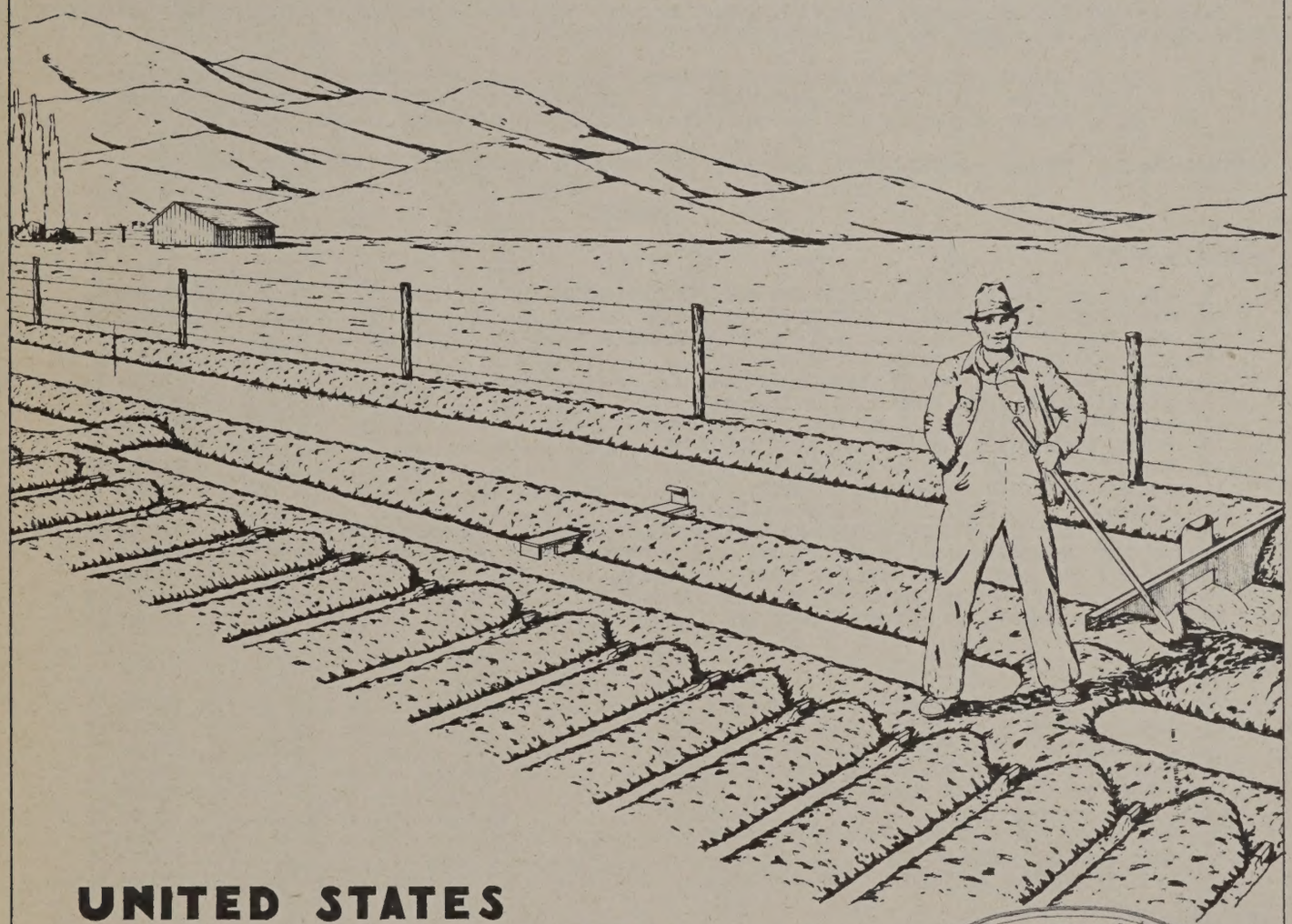
FIRST AID FOR THE IRRIGATOR



UNITED STATES
DEPARTMENT OF AGRICULTURE
FARM SECURITY ADMINISTRATION

OFFICE OF AREA ENGINEER

WATER CONSERVATION AND UTILIZATION

DENVER, COLORADO

MAY 1943

FIRST AID FOR THE IRRIGATOR

BY IVAN D. WOOD, AREA ENGINEER
WATER CONSERVATION AND UTILIZATION
FARM SECURITY ADMINISTRATION, DENVER, COLORADO

FOREWORD

MOST OF THE IRRIGATION PRACTICES AND DESIGNS OF STRUCTURES AND EQUIPMENT SHOWN IN THIS CIRCULAR ARE NOT NEW. SOME HAVE BEEN EMPLOYED BY FARMERS OF THE WEST FOR MANY YEARS BUT ACCURATE DRAWINGS AND DESCRIPTIONS HAVE SELDOM BEEN AVAILABLE FOR THE USE OF OTHERS. IN SOME INSTANCES THE GOOD FEATURES OF SEVERAL DESIGNS HAVE BEEN COMBINED AND A NEW ONE DEVELOPED.

THE VARIOUS PRACTICES DEPICTED ARE THE RESULT OF THE COMBINED EXPERIENCES OF PRACTICAL IRRIGATORS, IRRIGATION ENGINEERS AND OTHERS WHO HAVE HAD INTIMATE ASSOCIATION WITH THE ART OF WATER APPLICATION.

ACKNOWLEDGEMENT

VALUABLE CONTRIBUTIONS TO THIS CIRCULAR HAVE BEEN MADE BY MANY PERSONS. THE FOLLOWING INDIVIDUALS HAVE COOPERATED IN THE PREPARATION OF MATERIAL AND HAVE OFFERED CONSTRUCTIVE CRITICISM:

H. F. McCOLLY, CHIEF WATER FACILITIES ENGINEER, FARM SECURITY ADMINISTRATION, DENVER, COLORADO
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R. O. PIERCE, ASSOCIATE CIVIL ENGINEER, FARM SECURITY ADMINISTRATION, DENVER, COLORADO

ILLUSTRATIONS BY: HOWARD A. MOORE, JUNIOR ARCHITECT, FARM SECURITY ADMINISTRATION, DENVER, COLORADO

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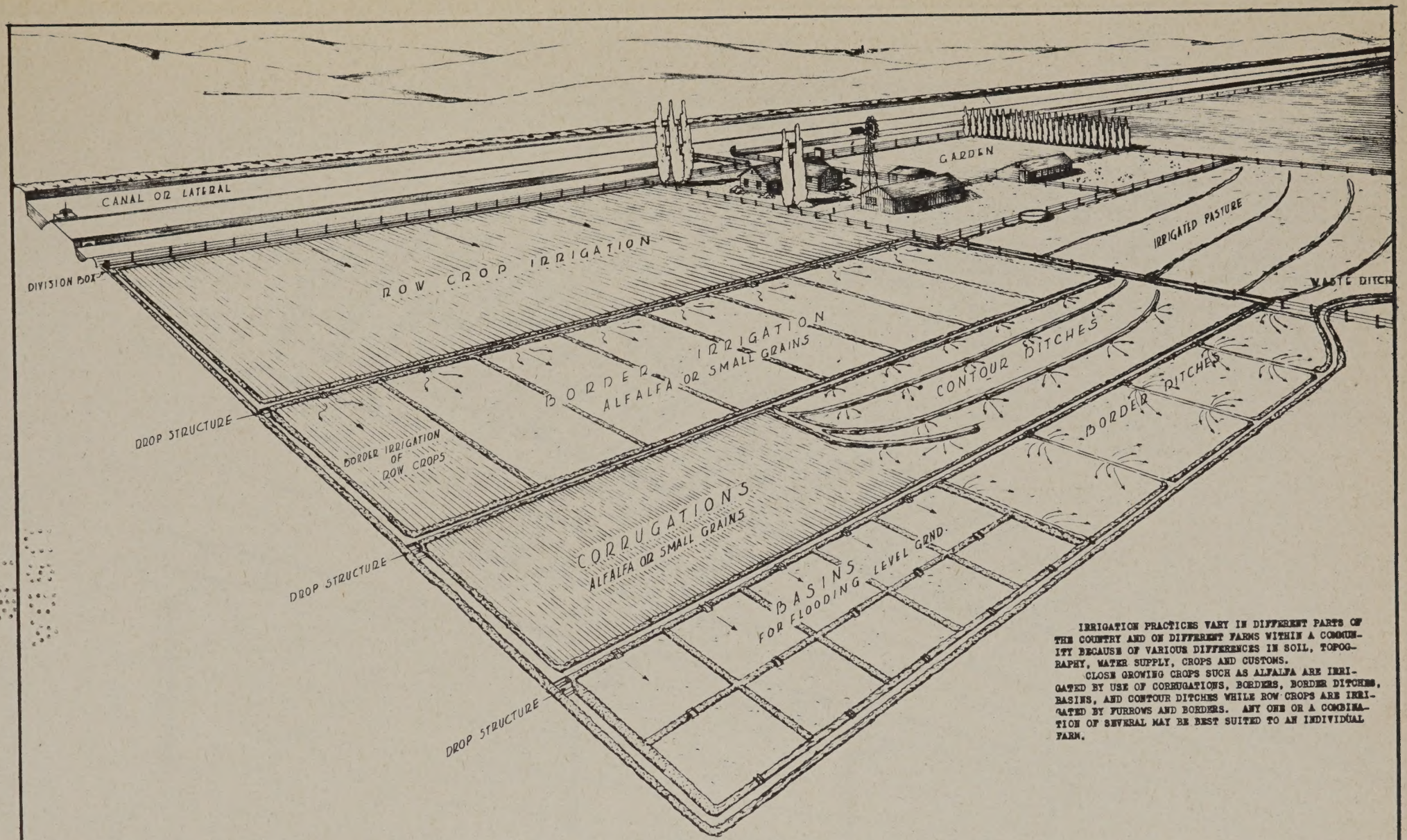
WATER APPLICATION

STRUCTURES

EQUIPMENT



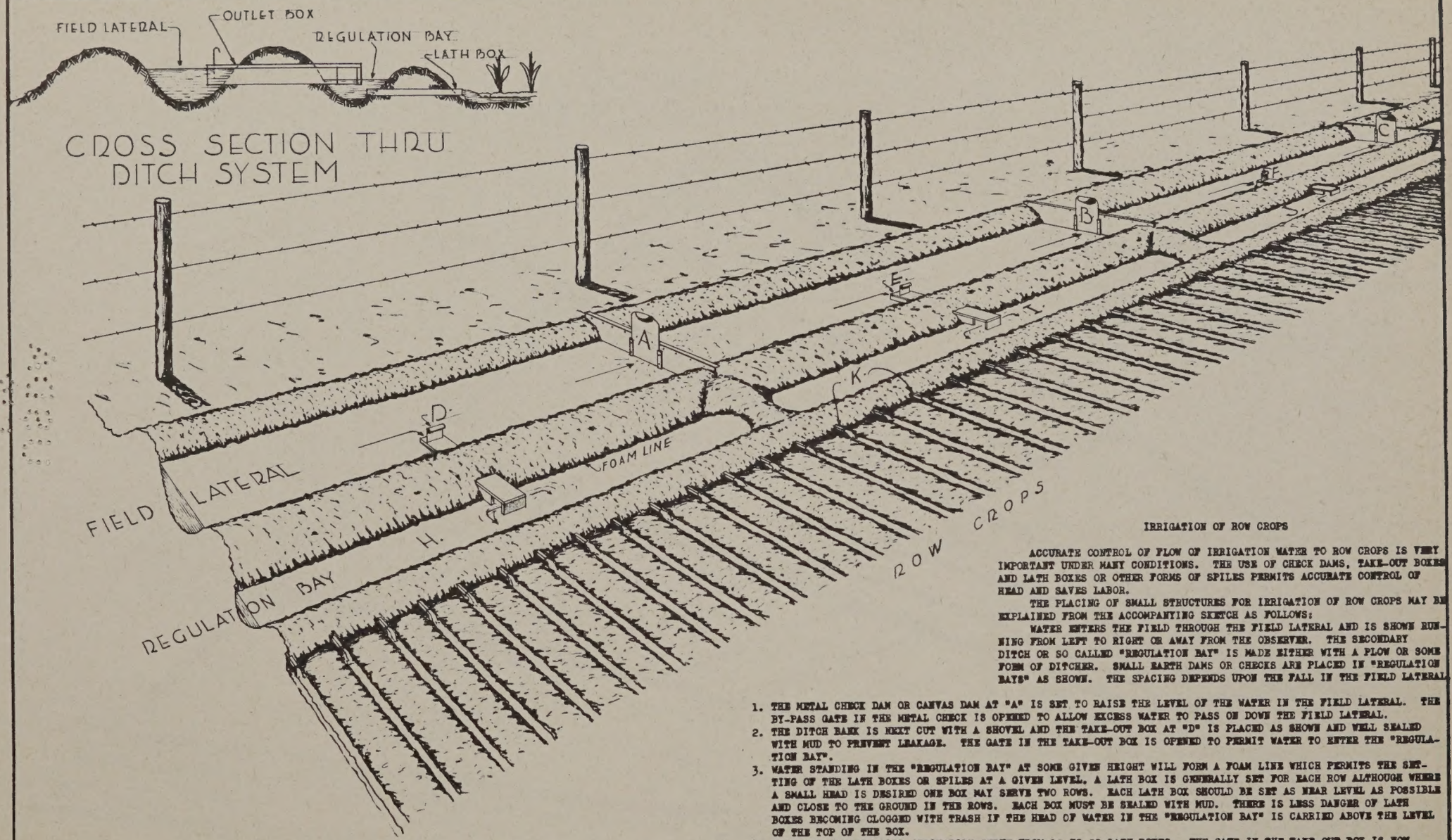
IRRIGATION PRACTICES VARY IN DIFFERENT PARTS OF THE COUNTRY AND ON DIFFERENT FARMS WITHIN A COMMUNITY BECAUSE OF VARIOUS DIFFERENCES IN SOIL, TOPOGRAPHY, WATER SUPPLY, CROPS AND CUSTOMS.

CLOSE GROWING CROPS SUCH AS ALFALFA ARE IRRIGATED BY USE OF CORRUGATIONS, BORDERS, BORDER DITCHES, BASINS, AND CONTOUR DITCHES WHILE ROW CROPS ARE IRRIGATED BY FURROWS AND BORDERS. ANY ONE OR A COMBINATION OF SEVERAL MAY BE BEST SUITED TO AN INDIVIDUAL FARM.

VARIOUS METHODS OF APPLYING IRRIGATION WATER TO FIELD CROPS

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER	IRRIGATION		F.313:24
COLORADO	STRUCTURES		D.3-16-43
Des. WOOD	Dr. MOORE	Tr. MOORE	Ck.

FIG. 1



IRRIGATION OF ROW CROPS FROM FIELD LATERAL USING SECONDARY DITCH, TAKE-OUT, AND LATH BOXES

FIG. 2

IRRIGATION OF ROW CROPS

ACCURATE CONTROL OF FLOW OF IRRIGATION WATER TO ROW CROPS IS VERY IMPORTANT UNDER MANY CONDITIONS. THE USE OF CHECK DAMS, TAKE-OUT BOXES AND LATH BOXES OR OTHER FORMS OF SPILES PERMITS ACCURATE CONTROL OF HEAD AND SAVES LABOR.

THE PLACING OF SMALL STRUCTURES FOR IRRIGATION OF ROW CROPS MAY BE EXPLAINED FROM THE ACCOMPANYING SKETCH AS FOLLOWS:

WATER ENTERS THE FIELD THROUGH THE FIELD LATERAL AND IS SHOWN RUNNING FROM LEFT TO RIGHT OR AWAY FROM THE OBSERVER. THE SECONDARY DITCH OR SO CALLED "REGULATION BAY" IS MADE EITHER WITH A PLOW OR SOME FORM OF DITCHER. SMALL EARTH DAMS OR CHECKS ARE PLACED IN "REGULATION BAYS" AS SHOWN. THE SPACING DEPENDS UPON THE FALL IN THE FIELD LATERAL.

1. THE METAL CHECK DAM OR CANVAS DAM AT "A" IS SET TO RAISE THE LEVEL OF THE WATER IN THE FIELD LATERAL. THE BY-PASS GATE IN THE METAL CHECK IS OPENED TO ALLOW EXCESS WATER TO PASS ON DOWN THE FIELD LATERAL.
2. THE DITCH BANK IS NEXT CUT WITH A SHOVEL AND THE TAKE-OUT BOX AT "D" IS PLACED AS SHOWN AND WELL SEALED WITH MUD TO PREVENT LEAKAGE. THE GATE IN THE TAKE-OUT BOX IS OPENED TO PERMIT WATER TO ENTER THE "REGULATION BAY".
3. WATER STANDING IN THE "REGULATION BAY" AT SOME GIVEN HEIGHT WILL FORM A FOAM LINE WHICH PERMITS THE SETTING OF THE LATH BOXES OR SPILES AT A GIVEN LEVEL. A LATH BOX IS GENERALLY SET FOR EACH ROW ALTHOUGH WHERE A SMALL HEAD IS DESIRED ONE BOX MAY SERVE TWO ROWS. EACH LATH BOX SHOULD BE SET AS NEAR LEVEL AS POSSIBLE AND CLOSE TO THE GROUND IN THE ROWS. EACH BOX MUST BE SEALED WITH MUD. THERE IS LESS DANGER OF LATH BOXES BECOMING CLOGGED WITH TRASH IF THE HEAD OF WATER IN THE "REGULATION BAY" IS CARRIED ABOVE THE LEVEL OF THE TOP OF THE BOX.
4. ONE TAKE-OUT BOX WILL ORDINARILY SERVE FROM 12 TO 20 LATH BOXES. THE GATE IN THE TAKE-OUT BOX IS NOW OPENED TO ALLOW THE DESIRED FLOW THROUGH THE LATH BOXES. THE QUANTITY OF WATER FLOWING THROUGH THE LATH BOX WILL DEPEND ON THE HEIGHT OF WATER ABOVE IT. THE GATE IN THE CHECK DAM IS THEN ACCURATELY SET TO MAINTAIN THE PROPER HEAD IN THE FIELD LATERAL.
5. AFTER ONE BAY HAS BEEN SET THE SAME PROCESS AS HAS BEEN DESCRIBED IS REPEATED IN THE SECOND BAY AS SHOWN AT "I" AND SO ON UNTIL THE ENTIRE HEAD IN THE FIELD LATERAL IS USED.

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER COLORADO	IRRIGATION STRUCTURES		F. 313:22 D. 3-13-43
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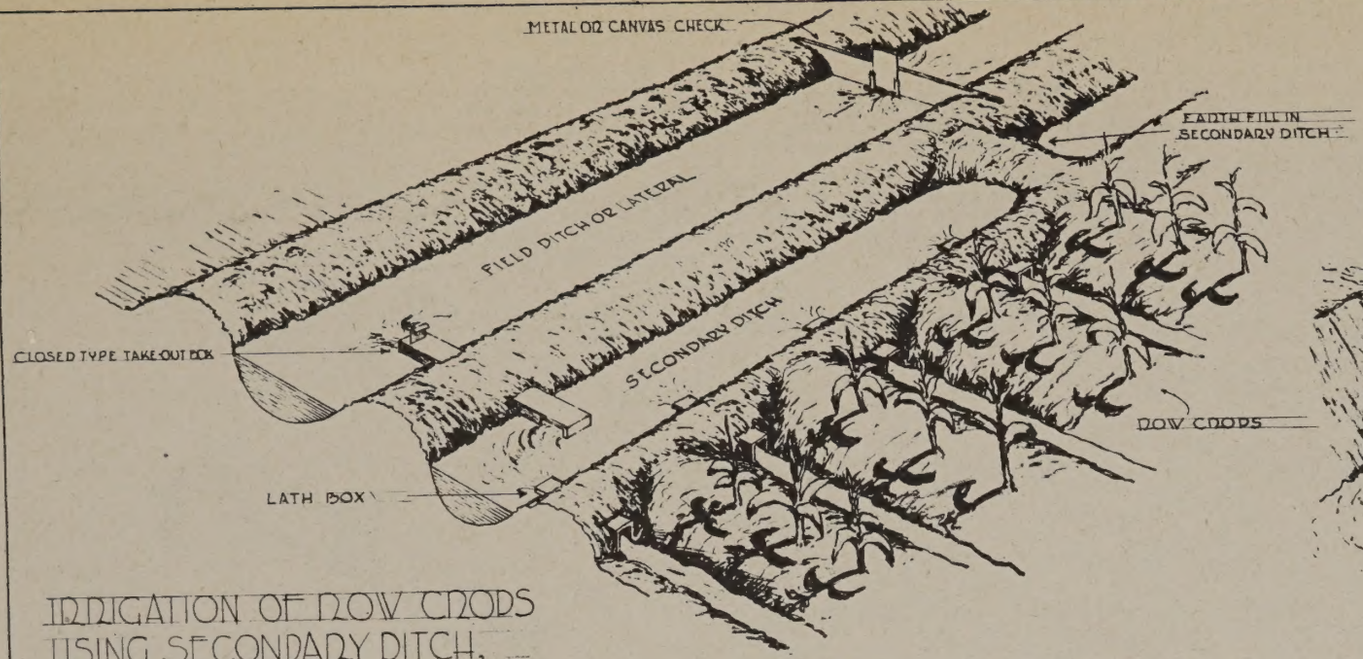
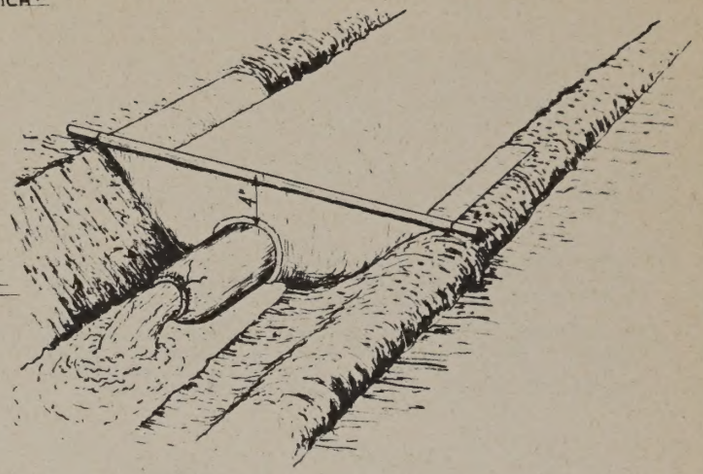
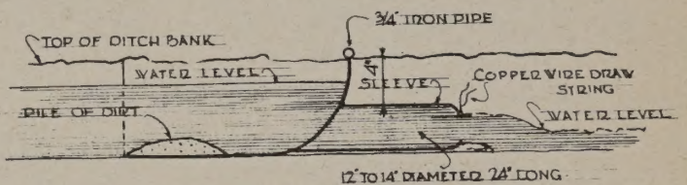


IRRIGATION OF ROW CROPS USING SECONDARY DITCH, TAKE-OUT BOXES AND LATH BOXES.



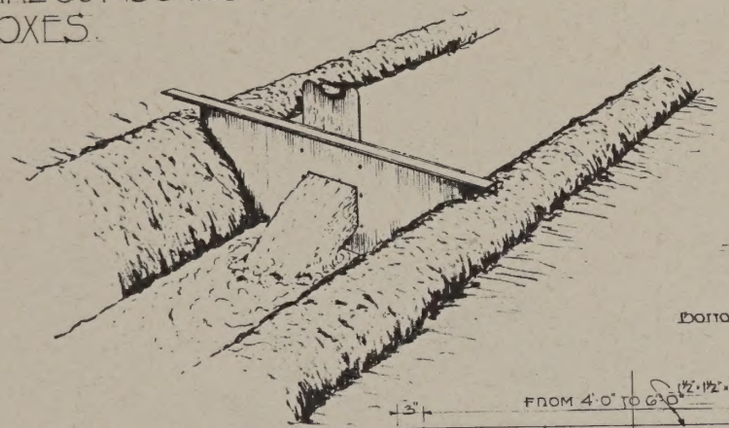
CANVAS CHECK DAM IN PLACE

NOTE:
IRON PIPE 8'-0" LONG - CANVAS - 7'-0" WIDE ON PIPE x 4'-0" LONG

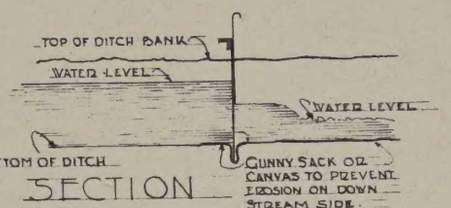


SECTION

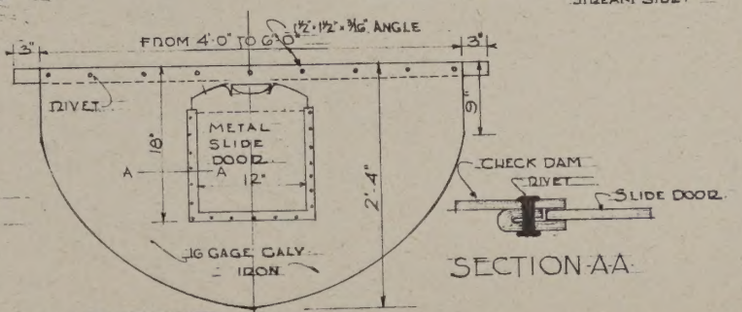
CANVAS CHECK DAM



METAL CHECK DAM IN PLACE



SECTION



METAL CHECK DAM

ELEVATION SCALE 1"=1'-0"

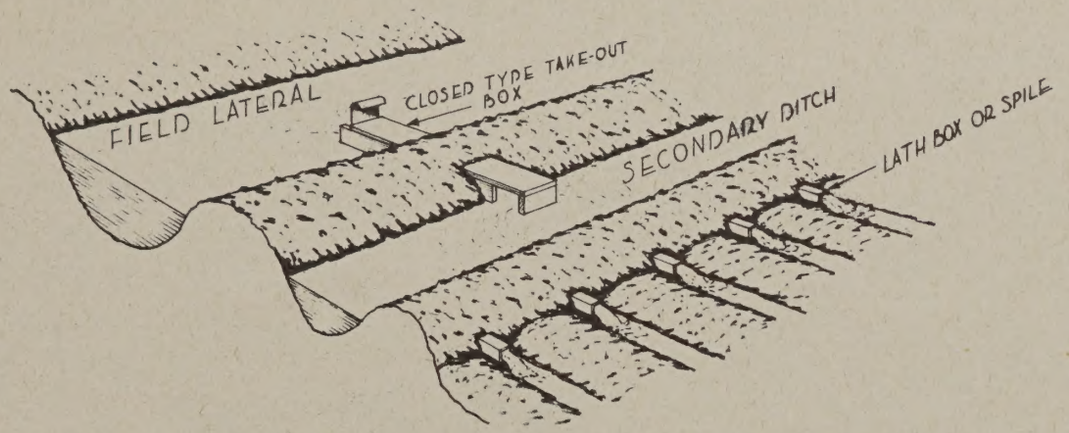
SECTION A-A

TO DIVERT WATER FROM A FIELD LATERAL IT IS USUALLY NECESSARY TO USE SOME TYPE OF CHECK TO RAISE THE WATER LEVEL. THE METAL TYPE CHECK MADE OF 16 GAGE GALVANIZED IRON IS POPULAR WITH IRRIGATION FARMERS. IT IS ORDINARILY PROVIDED WITH AN ADJUSTABLE GATE TO BYPASS PART OF THE SUPPLY. IN LIGHT SANDY SOILS IT MAY BE NECESSARY TO USE A SACK ON THE DOWNSTREAM SIDE TO PREVENT EROSION AS WATER FLOWS THROUGH THE GATE.

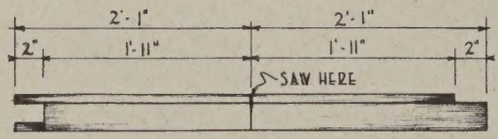
THE CANVAS CHECK IS LIGHT AND EASILY MOVED FROM PLACE TO PLACE. THE TYPE SHOWN IS MADE WITH AN OUTLET BOOT TO BYPASS A PART OF THE FLOW. THE REGULATION IS ACCOMPLISHED BY OPENING OR CLOSING THE DRAW STRING. A FEW SHOVELS OF EARTH ON THE UPSTREAM SIDE HOLDS THE CANVAS IN POSITION.

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER COLORADO	IRRIGATION STRUCTURES		F. 31511 D.G/20/42
Des. WOOD	Dr. MOOTZE	Tr.	Ck.

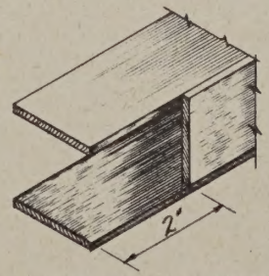
FIG. 3



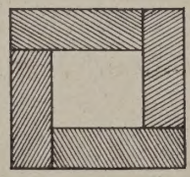
CLOSED TYPE TAKE OUT BOX AND LATH BOXES IN PLACE



ELEVATION- LATH BOX
NOT TO SCALE

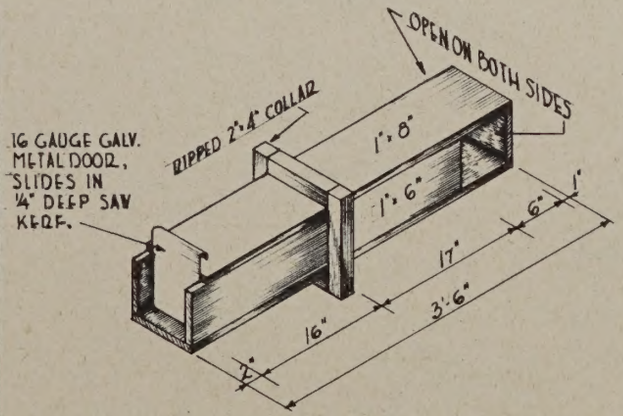


METHOD OF STAGGERING LATH AT ENTRANCE END TO PREVENT CLOGGING WITH TRASH.



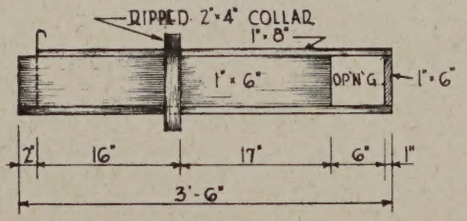
ARRANGEMENT OF LATH

NOTE:
LIGHT METAL PIPE, HOSE AND PLASTIC PIPE ARE SOMETIMES USED IN PLACE OF LATH BOXES.



ISOMETRIC

SCALE IN INCHES



SIDE ELEVATION

SCALE IN INCHES

CLOSED TYPE TAKE-OUT BOX

THE CLOSED TYPE OUTLET BOX IS USED TO CONDUCT WATER THROUGH THE BANK OF A LATERAL TO A SECONDARY DITCH AND TO CONTROL THE FLOW. IN THE DESIGN SHOWN ABOVE THE SIDE PIECES OF 1" x 6" MATERIAL ARE CUT 6" SHORTER THAN THE TOP AND BOTTOM PIECES. ONE OF THE 6" x 6" BLOCKS IS NAILED IN THE OUTLET END TO FORM TWO SIDE OPENINGS. WATER FLOWING FROM THE TWO SIDE OPENINGS PREVENTS EROSION OF THE OPPOSITE BANK.

IN IRRIGATION OF ROW CROPS THE USE OF THE CLOSED TYPE OUTLET BOX, SECONDARY DITCH AND LATH BOXES, PERMITS A UNIFORM, CONTROLLED DISTRIBUTION OF WATER TO EACH ROW AND IS MORE ECONOMICAL OF LABOR THAN THE OLD METHOD OF CUTTING THE DITCH BANK AND ATTEMPTING TO GUIDE WATER INTO EACH ROW WITH A SHOVEL.

SEE SHEET 2 FOR FURTHER EXPLANATION.

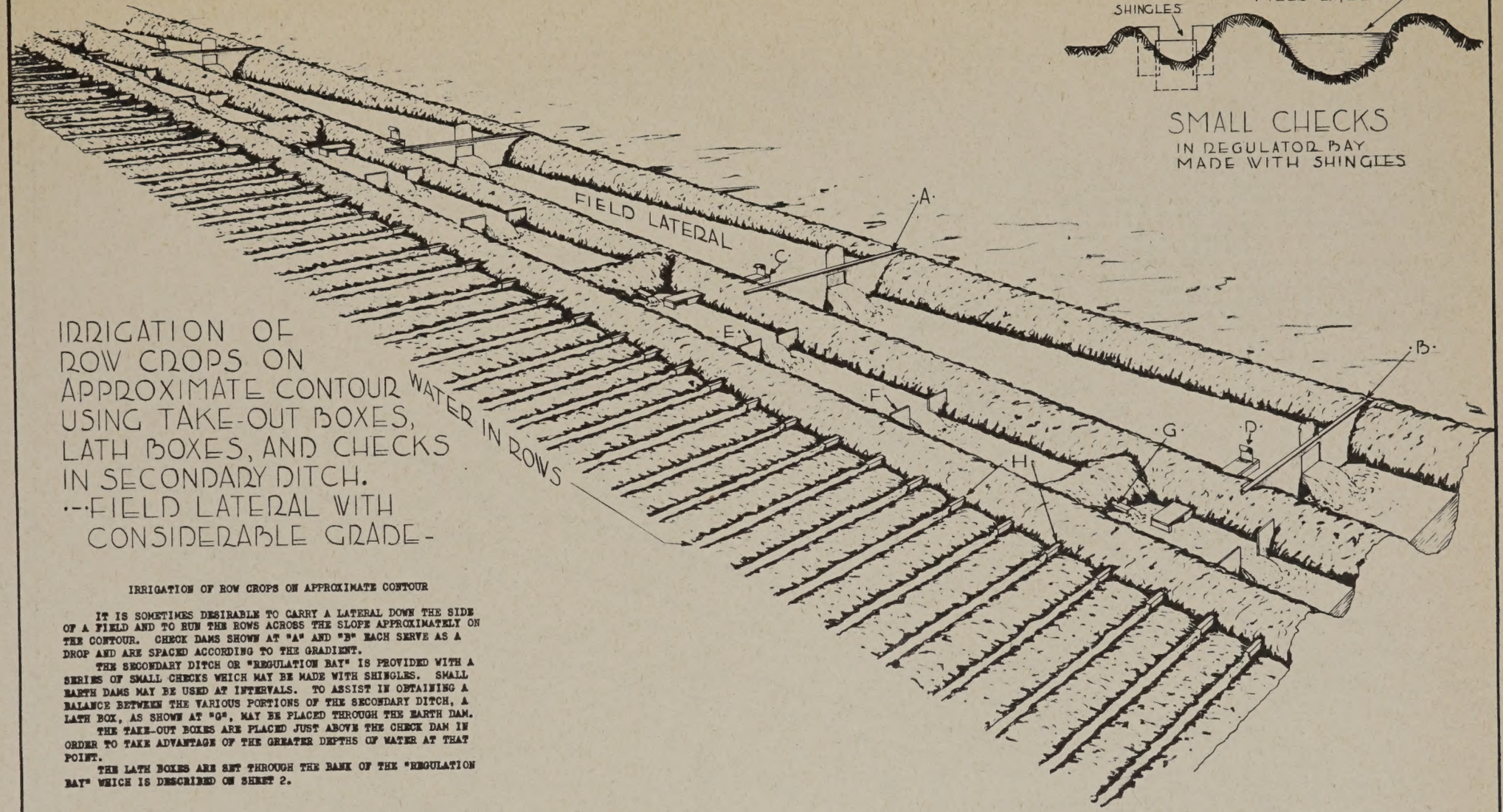
LATH BOXES

MANY FORMS OF SPILES ARE IN USE IN IRRIGATED SECTIONS BUT THE LATH BOX IS CHEAP AND CONVENIENT. IT IS MADE BY NAILING FOUR FULL LENGTH LATH TOGETHER AS SHOWN AND SAWING AT THE CENTER TO FORM TWO BOXES EACH APPROXIMATELY 2 FEET LONG. THE LATH ARE STAGGERED AT THE ENTRANCE END TO PREVENT CLOGGING WITH LEAVES OR TRASH.

IT IS ADVISABLE TO USE GALVANIZED NAILS AND TO TREAT THE BOXES WITH CREOSOTE OR TO SOAK THEM 24 HOURS IN USED CRANK CASE OIL. FOR ADDITIONAL DISCUSSION ON IRRIGATION OF ROW CROPS SEE SHEETS 2 AND 3.

USDA	FARM SECURITY ADMINISTRATION	USDA
DENVER COLORADO	IRRIGATION STRUCTURES	F.313: 3 D.4-21-43
Des. WOOD	Dr. MOORE	Tr. MOORE	Ck.

FIG. 4



SMALL CHECKS
IN REGULATOR BAY
MADE WITH SHINGLES

IRRIGATION OF ROW CROPS ON APPROXIMATE CONTOUR USING TAKE-OUT BOXES, LATH BOXES, AND CHECKS IN SECONDARY DITCH. --FIELD LATERAL WITH CONSIDERABLE GRADE-

IRRIGATION OF ROW CROPS ON APPROXIMATE CONTOUR

IT IS SOMETIMES DESIRABLE TO CARRY A LATERAL DOWN THE SIDE OF A FIELD AND TO RUN THE ROWS ACROSS THE SLOPE APPROXIMATELY ON THE CONTOUR. CHECK DAMS SHOWN AT "A" AND "B" EACH SERVE AS A DROP AND ARE SPACED ACCORDING TO THE GRADIENT.

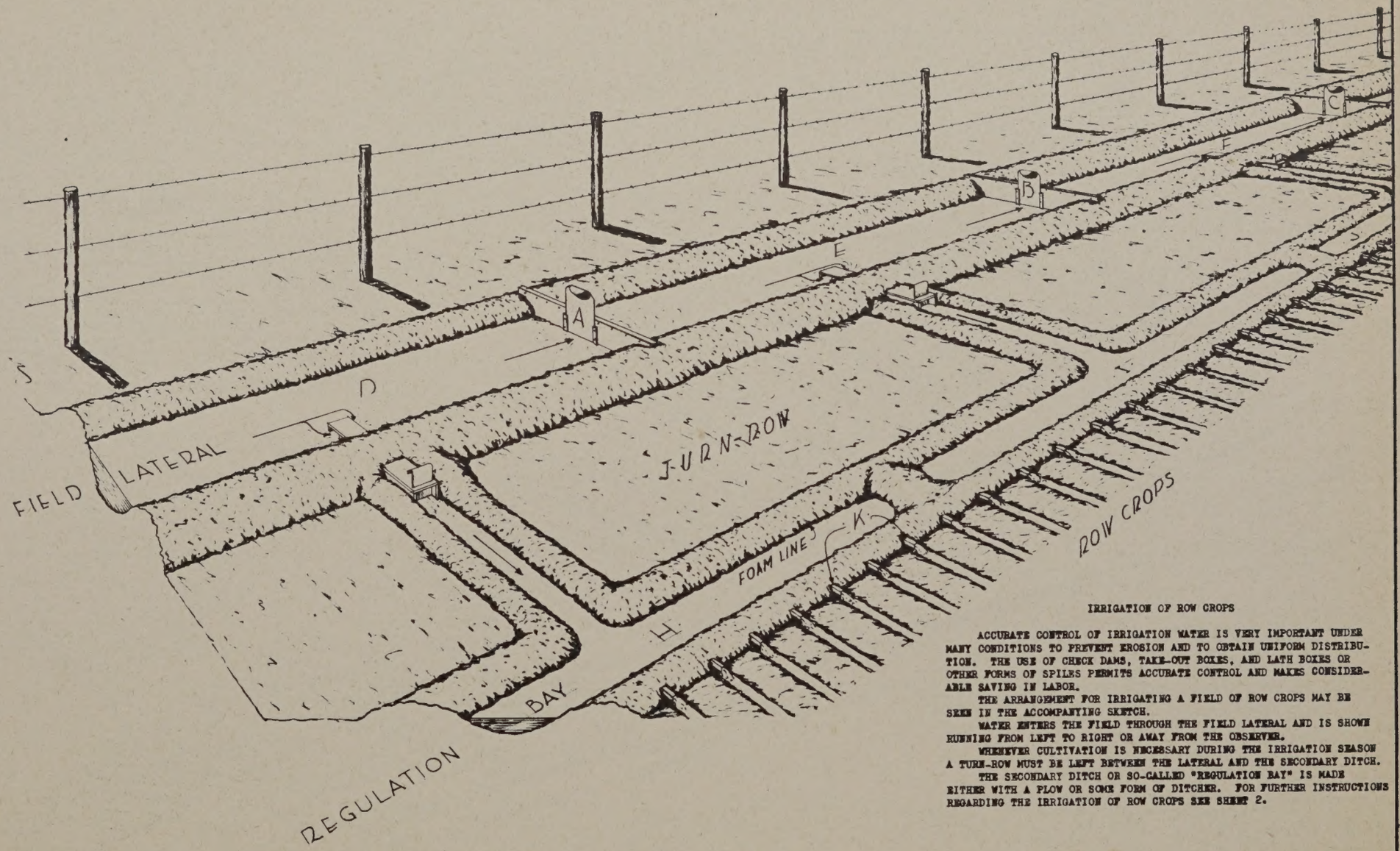
THE SECONDARY DITCH OR "REGULATION BAY" IS PROVIDED WITH A SERIES OF SMALL CHECKS WHICH MAY BE MADE WITH SHINGLES. SMALL EARTH DAMS MAY BE USED AT INTERVALS. TO ASSIST IN OBTAINING A BALANCE BETWEEN THE VARIOUS PORTIONS OF THE SECONDARY DITCH, A LATH BOX, AS SHOWN AT "G", MAY BE PLACED THROUGH THE EARTH DAM.

THE TAKE-OUT BOXES ARE PLACED JUST ABOVE THE CHECK DAM IN ORDER TO TAKE ADVANTAGE OF THE GREATER DEPTHS OF WATER AT THAT POINT.

THE LATH BOXES ARE SET THROUGH THE BANK OF THE "REGULATION BAY" WHICH IS DESCRIBED ON SHEET 2.

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER COLORADO	IRRIGATION STRUCTURES		F. 313: 20 D. 3-10-43
Des. WOOD	Dr. MOORE	Tr. MOORE	Ck.

FIG. 5



IRRIGATION OF ROW CROPS

ACCURATE CONTROL OF IRRIGATION WATER IS VERY IMPORTANT UNDER MANY CONDITIONS TO PREVENT EROSION AND TO OBTAIN UNIFORM DISTRIBUTION. THE USE OF CHECK DAMS, TAKE-OUT BOXES, AND LATH BOXES OR OTHER FORMS OF SPILES PERMITS ACCURATE CONTROL AND MAKES CONSIDERABLE SAVING IN LABOR.

THE ARRANGEMENT FOR IRRIGATING A FIELD OF ROW CROPS MAY BE SEEN IN THE ACCOMPANYING SKETCH.

WATER ENTERS THE FIELD THROUGH THE FIELD LATERAL AND IS SHOWN RUNNING FROM LEFT TO RIGHT OR AWAY FROM THE OBSERVER.

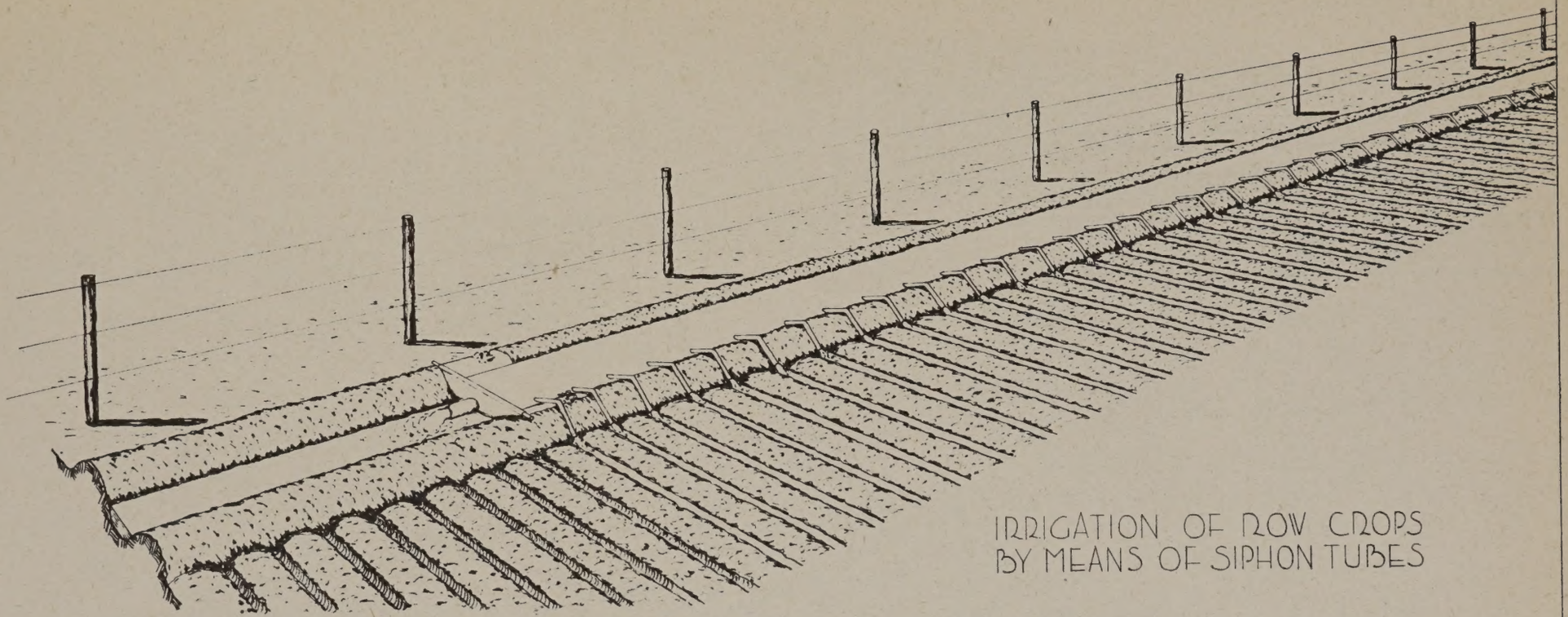
WHENEVER CULTIVATION IS NECESSARY DURING THE IRRIGATION SEASON A TURN-ROW MUST BE LEFT BETWEEN THE LATERAL AND THE SECONDARY DITCH.

THE SECONDARY DITCH OR SO-CALLED "REGULATION BAY" IS MADE EITHER WITH A PLOW OR SOME FORM OF DITCHER. FOR FURTHER INSTRUCTIONS REGARDING THE IRRIGATION OF ROW CROPS SEE SHEET 2.

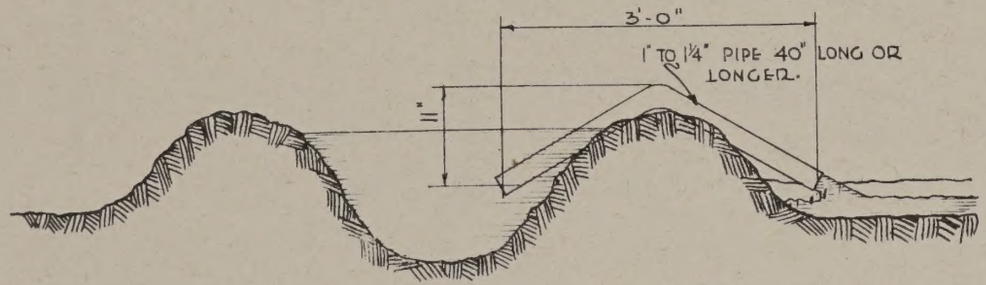
IRRIGATION OF ROW CROPS- USING A TURN-ROW BETWEEN FIELD LATERAL AND SECONDARY DITCH

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER COLORADO	IRRIGATION STRUCTURES		F. 313: 23 D-3-15-43
Des. WOOD	Dr. MOORE	Tr. MOORE	Ck.

FIG. 6



IRRIGATION OF ROW CROPS BY MEANS OF SIPHON TUBES



SECTION - DITCH & SIPHON

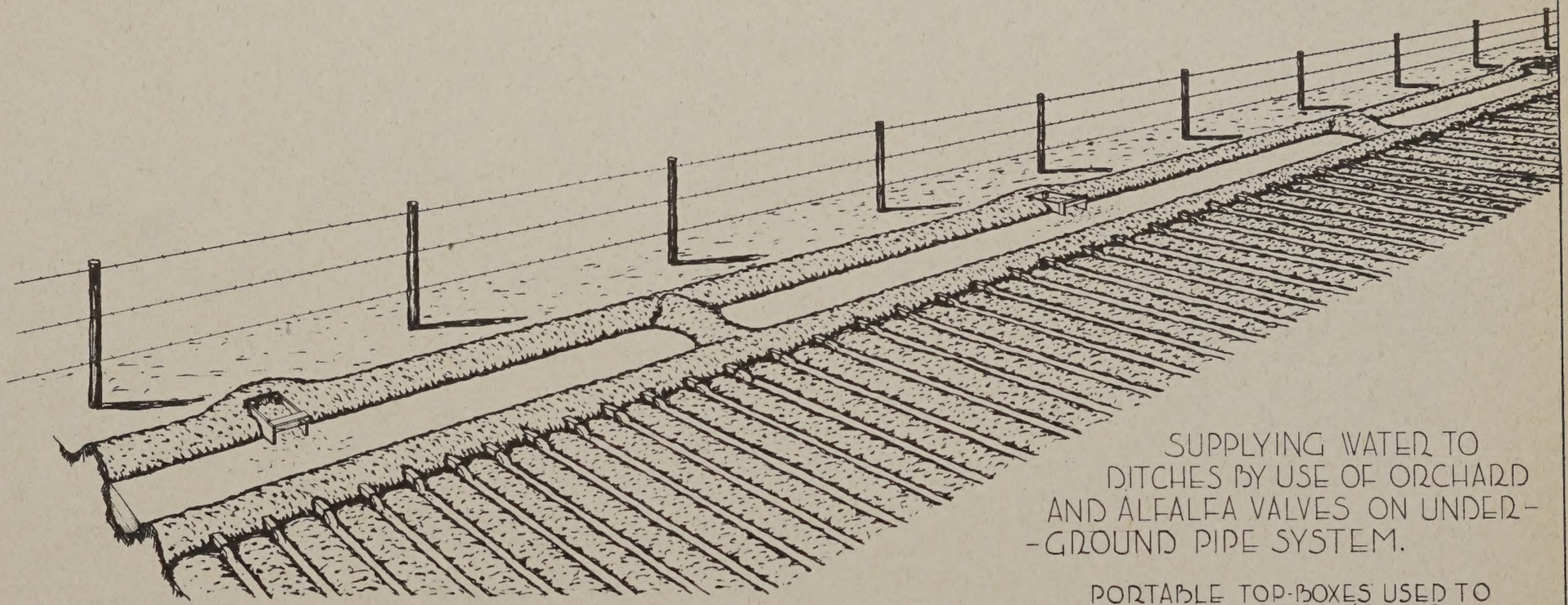
SIPHON TUBES MADE OF LIGHT METAL OR PLASTICS ARE SOMETIMES USED TO DISTRIBUTE WATER FROM A FIELD LATERAL TO FURROWS FOR IRRIGATION OF ROW CROPS. SOME IRRIGATORS PREFER THIS METHOD SINCE IT IS NOT NECESSARY TO CUT THE DITCH BANK TO PLACE THE TUBES AND THE USE OF A "REGULATION BAY" OR SECONDARY DITCH IS NOT REQUIRED. IT HAS THE DISADVANTAGE OF BEING DIFFICULT TO REGULATE AND IF FLOW IN THE LATERAL IS INTERRUPTED THE SIPHON ACTION IN ALL TUBES MUST BE STARTED AGAIN.

THE SIPHON ACTION IS STARTED AS FOLLOWS:

1. THE TUBE IS FILLED WITH WATER BY SUBMERGING IT IN THE CANAL.
2. THE HAND IS PLACED OVER ONE END AND THE TUBE SET IN POSITION AS SHOWN IN THE DRAWINGS.
3. WHEN THE HAND IS REMOVED FLOW WILL START AND MAY BE ADJUSTED BY RAISING OR LOWERING THE DISCHARGE END.
4. THE INTAKE END OF THE TUBE SHOULD BE PLACED FAR ENOUGH UNDER WATER TO ELIMINATE CLOGGING BY FLOATING TRASH.

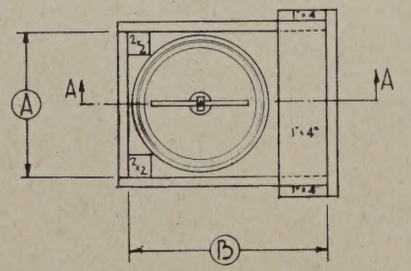
USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER COLORADO	IRRIGATION STRUCTURES		F.313:37 D.4-16-43
Des. PIERCE	Dr. MOORE	Tr. MOORE	Ck.

FIG. 7

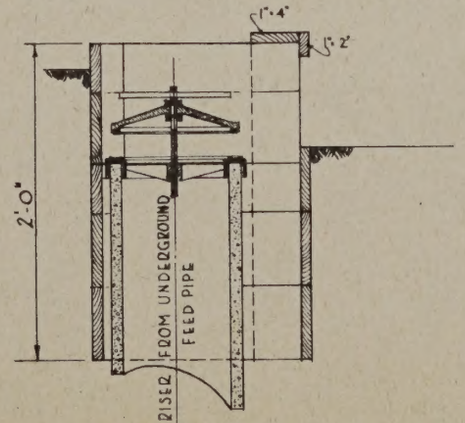


SUPPLYING WATER TO DITCHES BY USE OF ORCHARD AND ALFALFA VALVES ON UNDER-GROUND PIPE SYSTEM.

PORTABLE TOP-BOXES USED TO CONTROL EROSION AROUND VALVES ON SANDY SOIL, AND TO DIRECT FLOW OF WATER INTO IRRIGATION DITCHES



PLAN



SECTION A-A

TOP BOXES FOR ALFALFA VALVES

BOX DIMENSIONS SCHEDULE

SIZE OF RISER	BOX DIMENSIONS	
	Ⓐ	Ⓑ
8"	11"	15"
10"	13"	17"
12"	16"	20"
14"	18"	24"
16"	20"	26"

WATER FLOWING FROM AN "ALFALFA" OR "ORCHARD" VALVE UPON SANDY SOIL OFTEN WILL CAUSE EROSION BEFORE FLOWING INTO THE ADJACENT LATERAL.

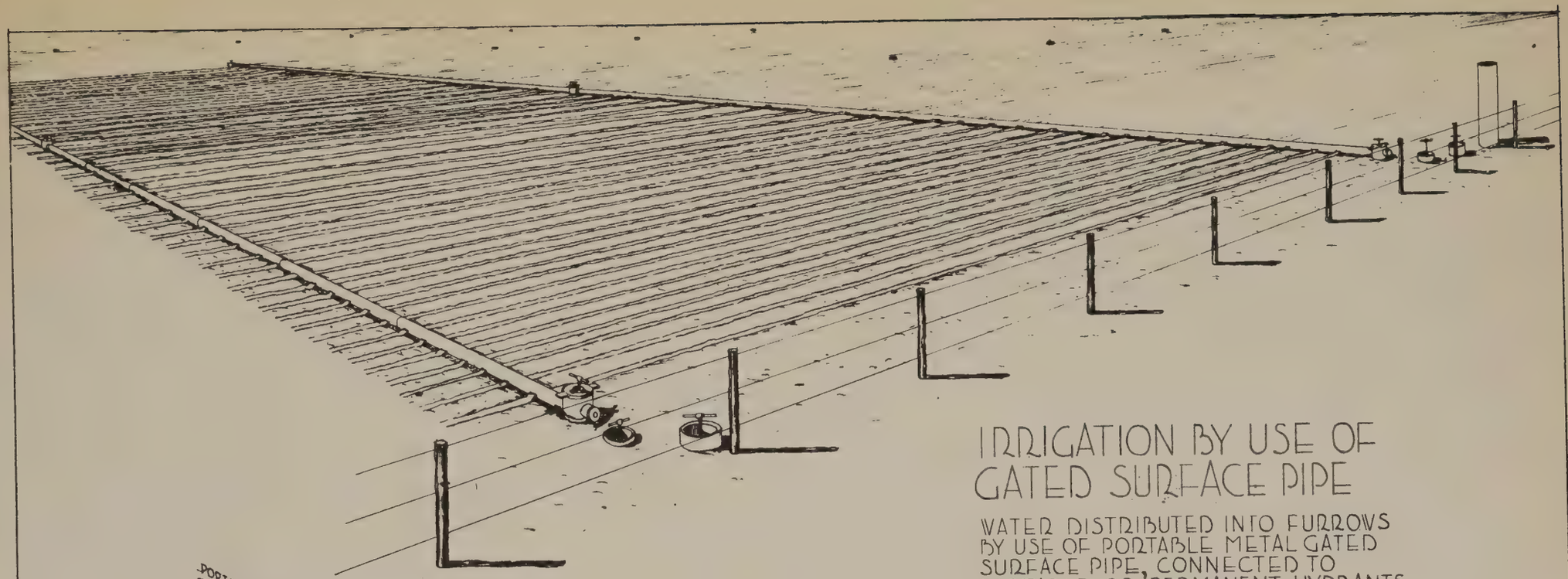
ONE SATISFACTORY METHOD OF ELIMINATING EROSION AND DIRECTING WATER INTO THE LATERAL IS BY THE USE OF A TOP BOX WHICH HAS THREE SIDES ENCLOSED AND IS FITTED AROUND THE VALVE AND RISER PIPE HIGH ENOUGH ABOVE THE GROUND SO THE WATER WILL NOT RUN OVER THE TOP. AS THE WATER IS RELEASED FROM THE VALVE IT ENTERS THE LATERAL FROM THE SIDE OPENING.

THE BOXES ARE PORTABLE AND CAN BE MOVED FROM PLACE TO PLACE AS DESIRED.

THE ACCOMPANYING TABLE GIVES DIMENSIONS OF VARIOUS SIZE BOXES NEEDED FOR VALVES OF DIFFERENT DIAMETERS.

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER COLORADO	IRRIGATION STRUCTURES		F.313:35 D.4-10-43
Des. FARMER	Dr. MOORE	Tr. MOORE	Ck.

FIG. 8

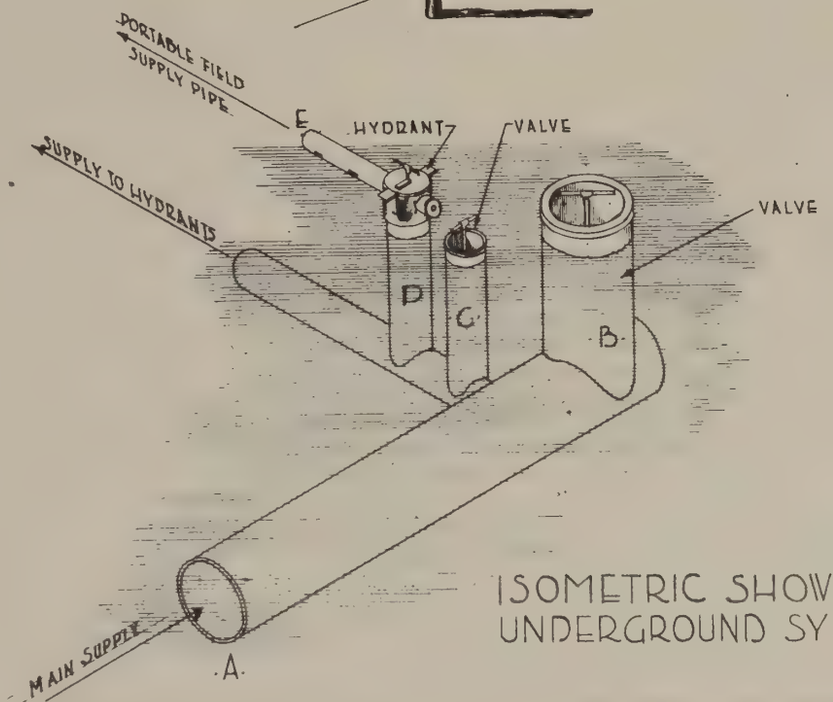


IRRIGATION BY USE OF GATED SURFACE PIPE

WATER DISTRIBUTED INTO FURROWS BY USE OF PORTABLE METAL GATED SURFACE PIPE, CONNECTED TO PORTABLE OR PERMANENT HYDRANTS. WATER SUPPLIED BY RESERVOIR OR DIRECT PUMPING INTO UNDER-GROUND CONCRETE PIPE DISTRIBUTION SYSTEM.

IRRIGATING LAND BY USE OF AN UNDERGROUND PIPE SUPPLY SYSTEM AND GATED SURFACE PIPE IS USED IN PARTS OF THE COUNTRY WHERE HIGH CROP RETURNS ARE REALIZED PER ACRE. THE SYSTEM IS EXPENSIVE TO INSTALL BUT HAS SEVERAL ADVANTAGES. IT CAN BE USED ON ROLLING TOPOGRAPHY WHERE OPEN DITCHES WOULD NOT BE FEASIBLE. THE USE OF GATED SURFACE PIPE MAKES A SAVING IN LABOR COSTS.

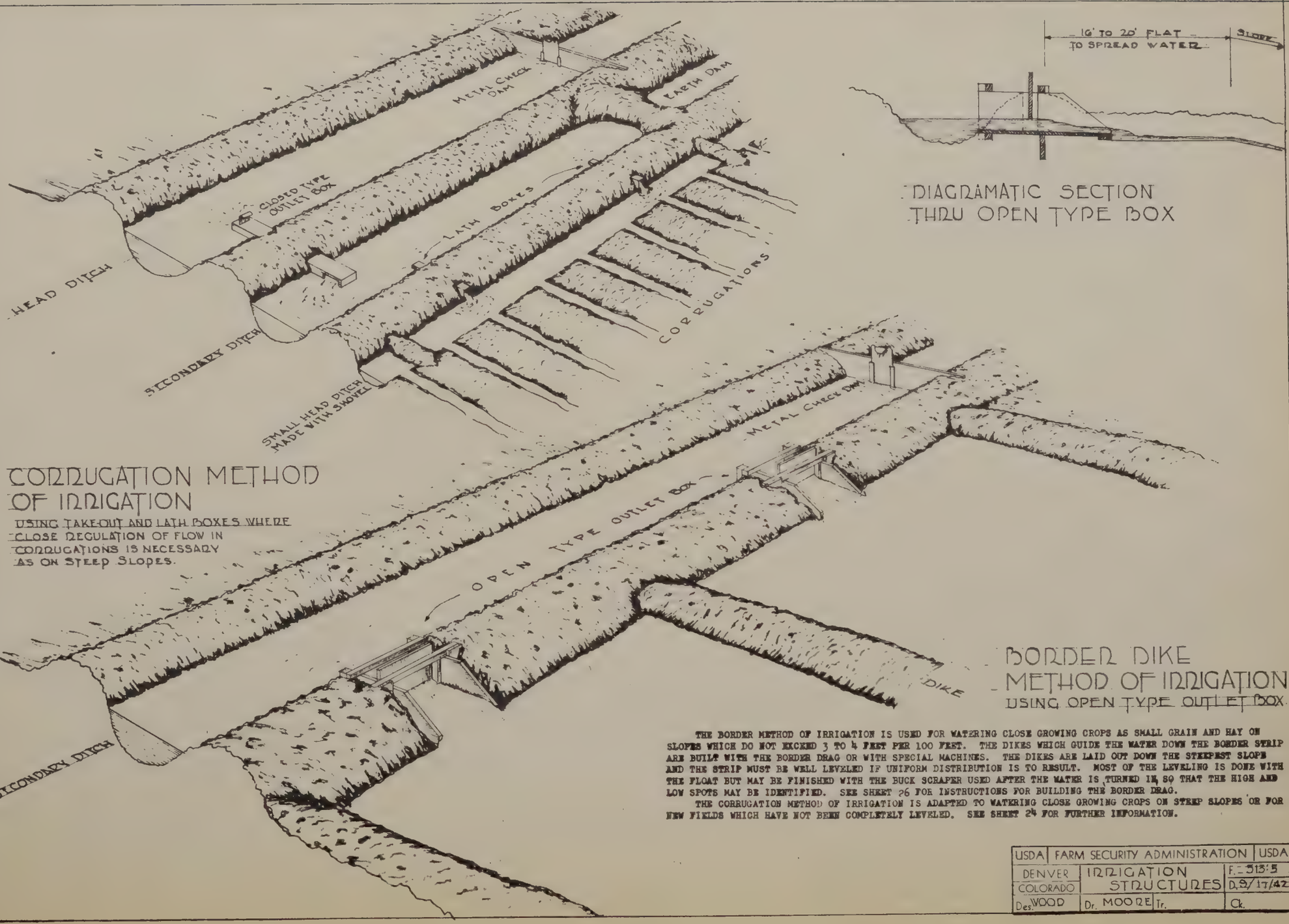
WATER IS TURNED INTO THE MAIN SUPPLY PIPE "A". VALVE "B" IS PARTIALLY OR COMPLETELY CLOSED. VALVE "C" IS OPENED AND WATER RUNS INTO THE SUPPLY PIPE TO HYDRANTS. THE METAL, GATED, SURFACE PIPE IS JOINTED TOGETHER AND CONNECTED TO THE PORTABLE OR PERMANENT HYDRANT "D". AS THE HYDRANT "D" IS OPENED WATER FLOWS INTO THE PORTABLE PIPE "E". WATER IS RELEASED FROM THE PIPE INTO THE FURROWS BY MEANS OF ADJUSTABLE METAL GATES. IN PRACTICE THE LOWER END OF THE FIELD IS IRRIGATED FIRST, THEN PROGRESSING UP HILL SO THERE WILL BE DRY SOIL UPON WHICH TO WORK WHEN LAYING THE SURFACE PIPE.



ISOMETRIC SHOWING UNDERGROUND SYSTEM

USDA	FARM SECURITY ADMINISTRATION	USDA
DENVER COLORADO	IRRIGATION STRUCTURES	F. 313:29 D.3-31-43
Des. PIERCE	Dr. MOORE	Tr. MOORE	Ck.

FIG. 9



DIAGRAMATIC SECTION THRU OPEN TYPE BOX

CORRUGATION METHOD OF IRRIGATION

USING TAKE-OUT AND LATH BOXES WHERE CLOSE REGULATION OF FLOW IN CORRUGATIONS IS NECESSARY AS ON STEEP SLOPES.

BORDER DIKE METHOD OF IRRIGATION

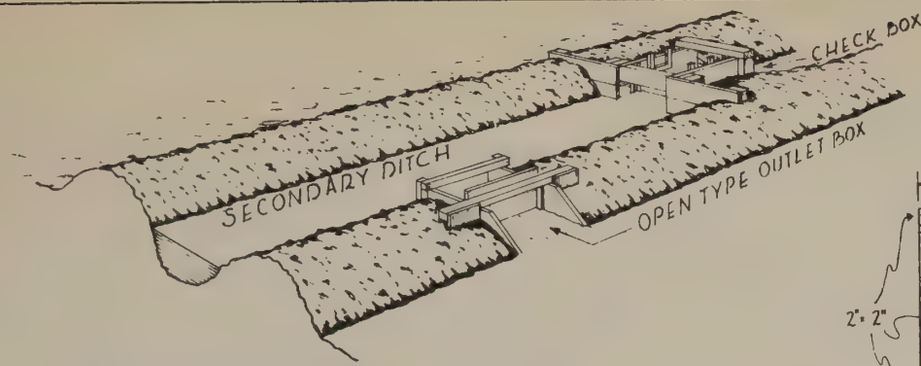
USING OPEN TYPE OUTLET BOX

THE BORDER METHOD OF IRRIGATION IS USED FOR WATERING CLOSE GROWING CROPS AS SMALL GRAIN AND HAY ON SLOPES WHICH DO NOT EXCEED 3 TO 4 FEET PER 100 FEET. THE DIKES WHICH GUIDE THE WATER DOWN THE BORDER STRIP ARE BUILT WITH THE BORDER DRAG OR WITH SPECIAL MACHINES. THE DIKES ARE LAID OUT DOWN THE STEEPEST SLOPE AND THE STRIP MUST BE WELL LEVELED IF UNIFORM DISTRIBUTION IS TO RESULT. MOST OF THE LEVELING IS DONE WITH THE FLOAT BUT MAY BE FINISHED WITH THE BUCK SCRAPER USED AFTER THE WATER IS TURNED IN, SO THAT THE HIGH AND LOW SPOTS MAY BE IDENTIFIED. SEE SHEET 26 FOR INSTRUCTIONS FOR BUILDING THE BORDER DRAG.

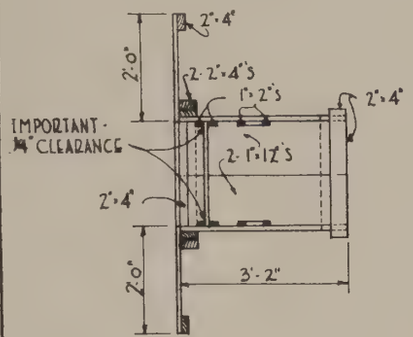
THE CORRUGATION METHOD OF IRRIGATION IS ADAPTED TO WATERING CLOSE GROWING CROPS ON STEEP SLOPES OR FOR NEW FIELDS WHICH HAVE NOT BEEN COMPLETELY LEVELED. SEE SHEET 24 FOR FURTHER INFORMATION.

USDA	FARM SECURITY ADMINISTRATION	USDA
DENVER COLORADO	IRRIGATION STRUCTURES	F. 513.5 D. 9/17/42
Des. WOOD	Dr. MOORE Tr.	Ck.

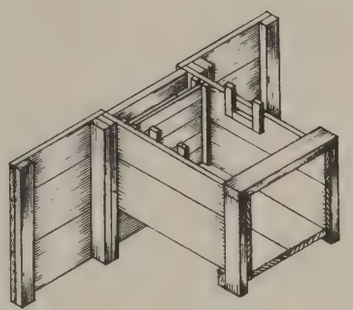
FIG. 10



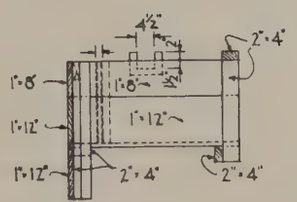
OPEN TYPE OUTLET BOX AND CHECK BOX IN PLACE



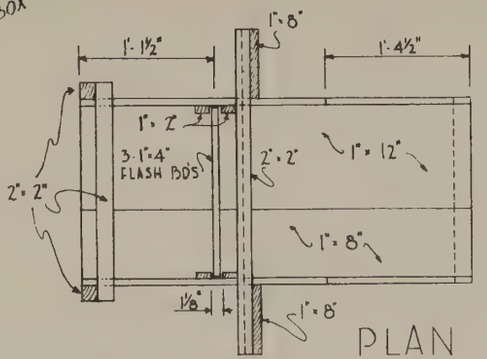
PLAN



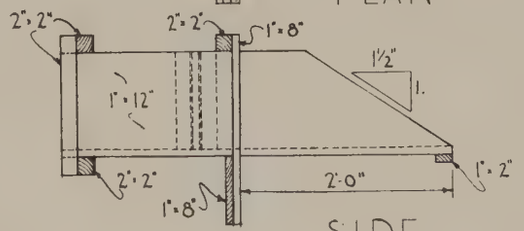
ISOMETRIC



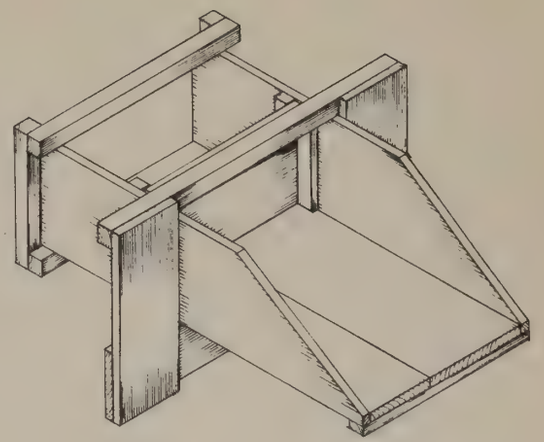
SIDE



PLAN



SIDE



ISOMETRIC

OPEN-TYPE OUTLET BOX

SCALE IN FEET

CHECK BOX

SCALE IN FEET

USE OF THE CHECK BOX AND OPEN TYPE OUTLET BOX

IN ADDITION TO THE TEMPORARY CHECKS AS SHOWN ON SHEET 3 IT IS OFTEN DESIRABLE TO HAVE PERMANENT CHECKS INSTALLED IN CANALS AND FIELD LATERALS AT POINTS WHERE DIVERSIONS ARE MADE. THE CHECK BOX SHOWN IN THE ILLUSTRATION IS MADE OF CREOSOTE TREATED MATERIAL. IT IS PROVIDED WITH SMALL CHECK BOARDS WHICH PERMIT ANY DESIRED HEAD TO BE CARRIED. EARTH MUST BE TIGHTLY COMPACTED AROUND THE STRUCTURE IF UNDERCUTTING IS TO BE PREVENTED.

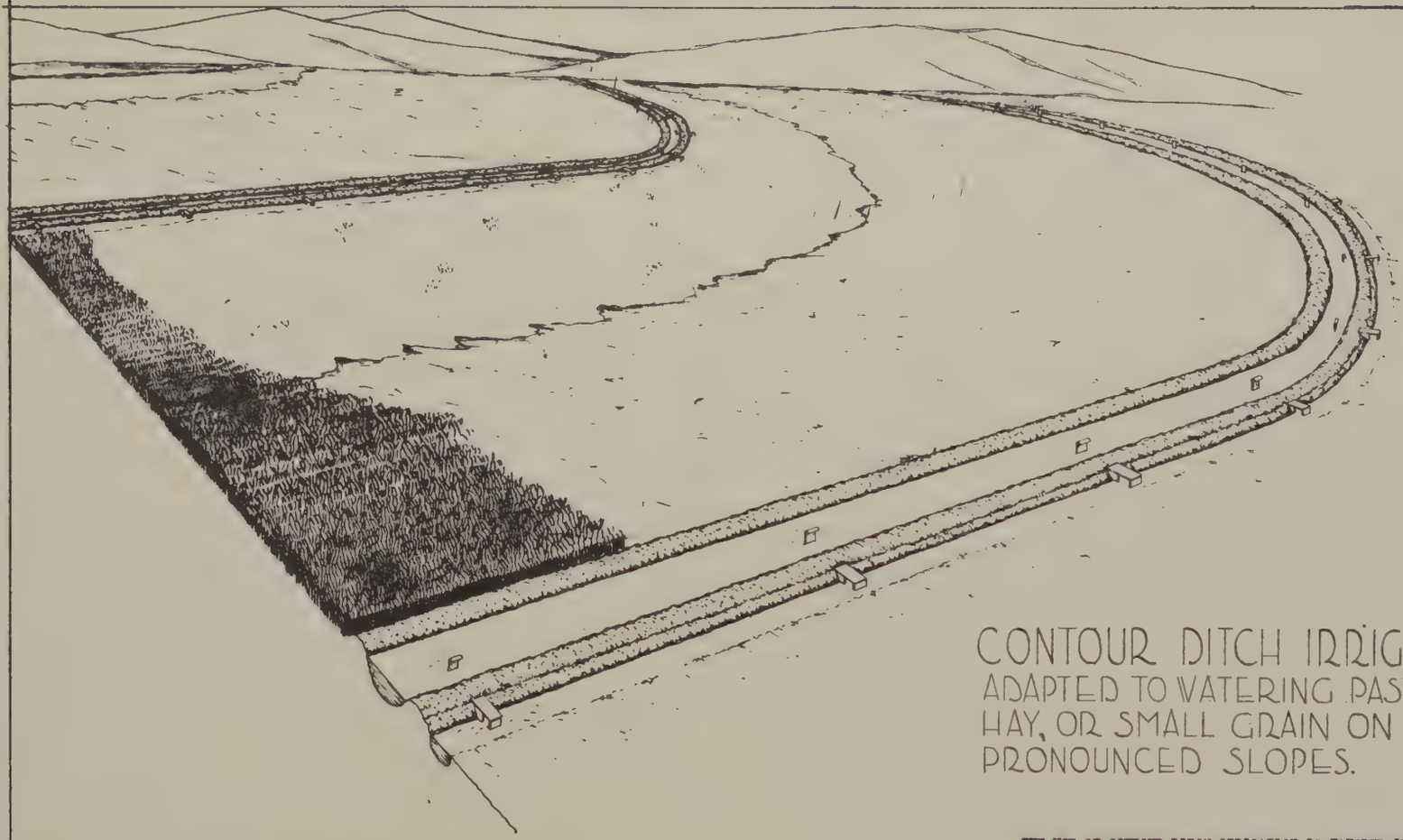
THE OPEN TYPE TAKE-OUT BOX IS USED PRIMARILY FOR DIVERTING WATER INTO THE UPPER END OF BORDERS FROM A FIELD LATERAL. IT PROVIDES A MEANS OF CONTROL AND IS MUCH TO BE PREFERRED TO MAKING A CUT IN THE LATERAL BANK WHICH RESULTS IN EROSION AND REQUIRES CONSTANT ATTENTION.

SEE SHEET 10 FOR OTHER APPLICATIONS OF THE OPEN TYPE TAKE-OUT BOX.

STRUCTURES OF THIS TYPE SHOULD BE NAILED WITH GALVANIZED, CEMENT COATED NAILS.

USDA	FARM SECURITY ADMINISTRATION	USDA
DENVER	IRRIGATION STRUCTURES	F. 313:41
COLORADO		D.4-22-43
Des. WOOD	Dr. MOORE	Tr. MOORE	Ck.

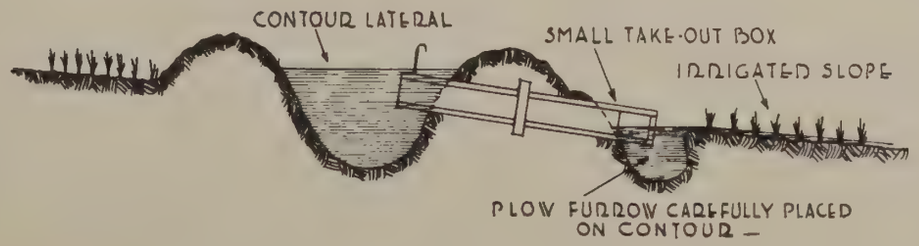
FIG. 11



CONTOUR DITCH IRRIGATION

ADAPTED TO WATERING PASTURE, HAY, OR SMALL GRAIN ON WELL PRONOUNCED SLOPES.

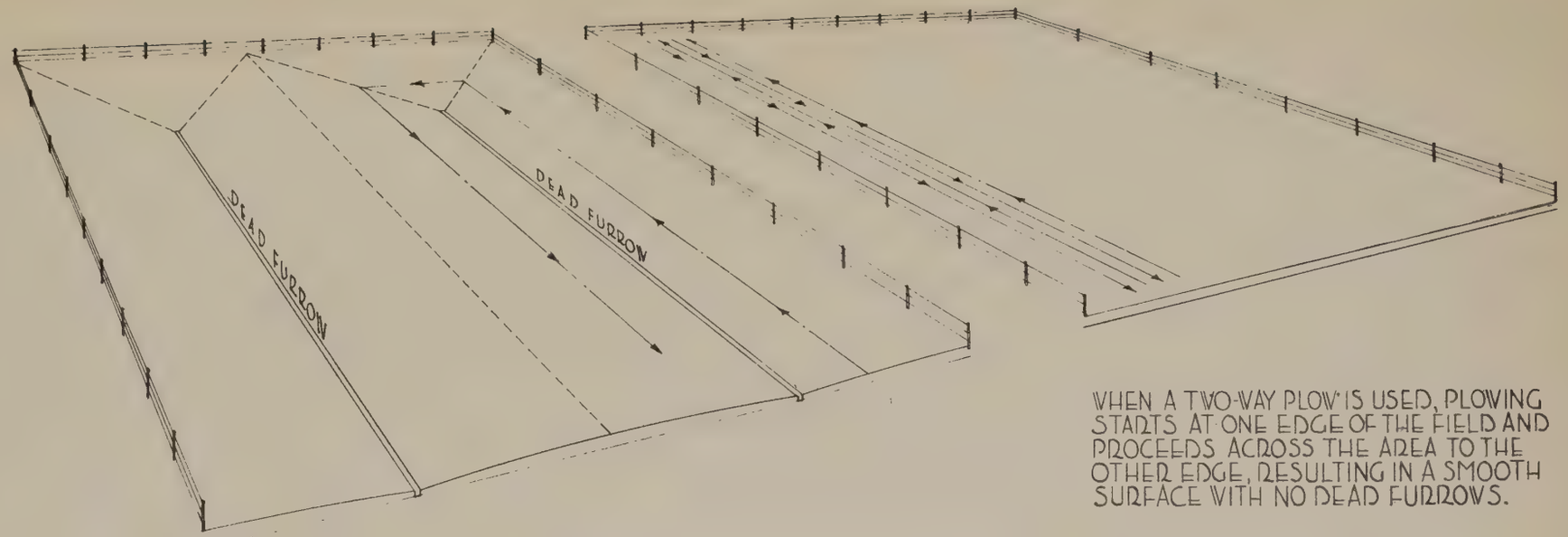
THE USE OF CONTOUR DITCH IRRIGATION IS FAVORED IN MANY SECTIONS FOR WATERING SMALL GRAIN, PASTURE AND HAY ON IRREGULAR SLOPES OR THOSE IN EXCESS OF 2 OR 3 PER CENT. THE SUCCESS OF THE SYSTEM DEPENDS UPON THE CARE WITH WHICH THE CONTOUR LATERALS ARE PLACED. IT IS CUSTOMARY TO BUILD THE DITCH ACROSS THE SLOPE WITH NO GRADE OR WITH LESS THAN 1/10 OF ONE FOOT PER 100 FEET. IN SOME CASES WATER IS DIVERTED TO THE LAND DIRECTLY FROM THE CONTOUR DITCH. A BETTER METHOD CONSISTS OF PLOWING A FURROW ON THE LOWER SIDE OF THE CONTOUR DITCH, THROWING THE FURROW SLICE UPHILL. THE FLOW IS DIVERTED FROM THE CONTOUR DITCH TO THE FURROW BY MEANS OF TAKE-OUT BOXES. WATER SPILLING OVER THE LIP OF THE FURROW PASSES DOWN OVER THE SLOPE IN A UNIFORM SHEET IF THE SYSTEM HAS BEEN CAREFULLY LAYED OUT AND CONSTRUCTED.



SECTION THRU DITCHES

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER	IRRIGATION STRUCTURES		F.313:28
COLORADO			D.3-29-43
Des. WOOD	Dr. MOORE	Tr. MOORE	Ck.

FIG. 12



WHEN A TWO-WAY PLOW IS USED, PLOWING STARTS AT ONE EDGE OF THE FIELD AND PROCEEDS ACROSS THE AREA TO THE OTHER EDGE, RESULTING IN A SMOOTH SURFACE WITH NO DEAD FURROWS.

EFFECT OF PLOWING A FIELD IN TWO LANDS WITH AN ORDINARY PLOW AND LEAVING DEAD FURROWS IN SAME LOCATION EACH YEAR. DIRT IS MOVED FROM THE DEADFURROW OUTWARD AT EACH PLOWING RESULTING IN AN UNEVEN SURFACE DIFFICULT TO IRRIGATE.

PLOWING OF IRRIGATED FIELDS

ONE TYPE OF TWO-WAY PLOW

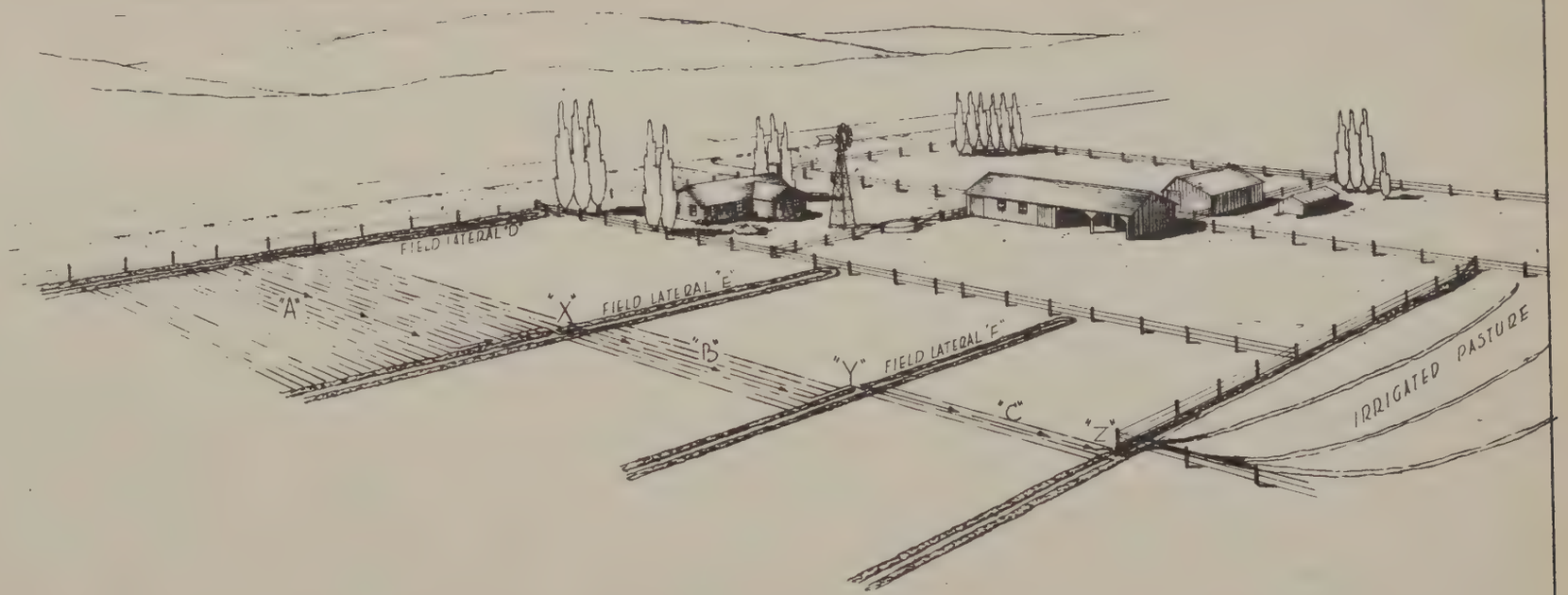
CORRECT PLOWING PRACTICES ARE IMPORTANT IF FIELD SURFACES ARE TO BE KEPT FROM BECOMING UNEVEN AND DIFFICULT TO IRRIGATE. ON DRY LAND FARMS IT IS COMMON PROCEDURE TO USE ORDINARY PLOWS AND TO PLOW FIELDS IN LANDS AS SHOWN ABOVE. THIS RESULTS IN MOVING SOIL OUTWARD FROM THE DEAD FURROW EACH SEASON UNTIL HIGH AND LOW AREAS ARE DEVELOPED.

EXPERIENCED IRRIGATION FARMERS PREFER TO USE A TWO-WAY PLOW WITH WHICH IT IS POSSIBLE TO START AT ONE EDGE OF A FIELD AND PLOW TO THE OTHER EDGE WITHOUT PRODUCING A DEAD FURROW AND WITHOUT LEAVING AN UNEVEN SURFACE.

IN USING THE IMPLEMENT ONE PLOW IS LOWERED FOR OPERATION AND ONE IS RAISED AS SHOWN IN THE ILLUSTRATION. WHEN ONCE ACROSS THE FIELD, THE OTHER PLOW IS LOWERED AND THE FIRST ONE RAISED ON THE RETURN TRIP. THE IRRIGATION FLOAT SHOULD BE USED OCCASIONALLY TO REMOVE MINOR IRREGULARITIES.

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER COLORADO	IRRIGATION STRUCTURES		F.313:39 D.4-19-43
Des. WOOD	Dr. MOORE	Tr. MOORE	Ck.

FIG. 13



USE OF EXCESS WATER IN ROW CROP IRRIGATION

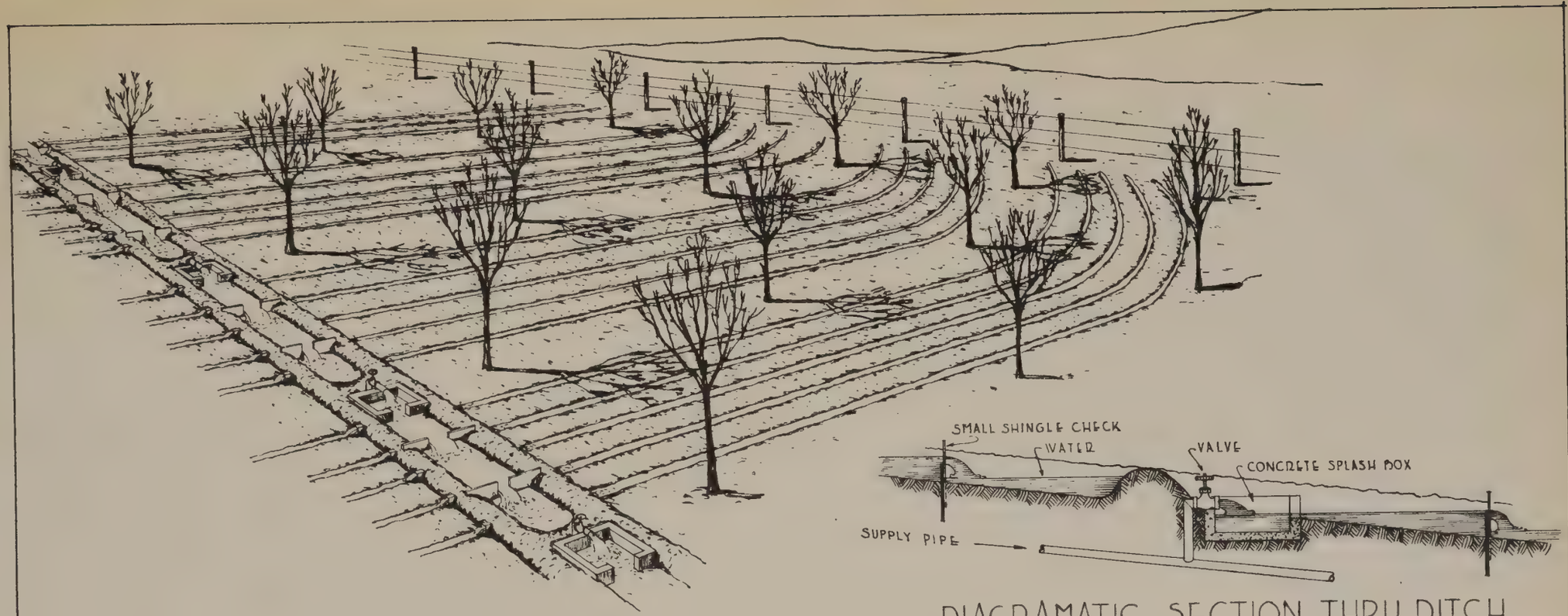
WASTAGE OF IRRIGATION WATER IS A COMMON CAUSE OF POOR DRAINAGE IN IRRIGATED AREAS. IT IS USUAL PRACTICE TO ALLOW A HEAD OF WATER TO RUN THROUGH ROWS OR BORDERS AND BE WASTED AT THE LOWER END OF A FIELD BY RUNNING INTO ROAD-SIDE DITCHES OR ELSEWHERE.

CARE IN THE HANDLING OF IRRIGATION WATER CAN RESULT IN SAVING OF BOTH WATER AND LABOR. A SET MAY BE MADE AT "A" AND ROWS IRRIGATED FROM LATERAL "D" DOWN THE SLOPE TOWARD LATERAL "E". THE WASTE WATER IS COLLECTED ABOVE LATERAL "E" AND CUT INTO IT AT "X". THIS EXCESS WATER IS USED TO IRRIGATE ADDITIONAL ROWS AT "B" AND THE EXCESS WATER USED AT "C". THE SAME PRACTICE MAY BE APPLIED IN THE CASE OF BORDERS OR CORRUGATIONS.

BY CAREFUL ARRANGEMENT OF FIELDS AND PASTURES THE WASTE WATER FROM ONE PORTION OF THE FARM MAY BE ECONOMICALLY APPLIED ELSEWHERE.

USDA	FARM SECURITY ADMINISTRATION	USDA
DENVER COLORADO	IRRIGATION STRUCTURES	F. 313:40 D. 4-21-43
Des. WOOD	Dr. MOORE Tr. MOORE	Ck.

FIG. 14



DIAGRAMATIC SECTION THRU DITCH

DIAGRAMATIC SECTION THRU ORCHARD

CONTOUR FURROW METHOD OF ORCHARD IRRIGATION

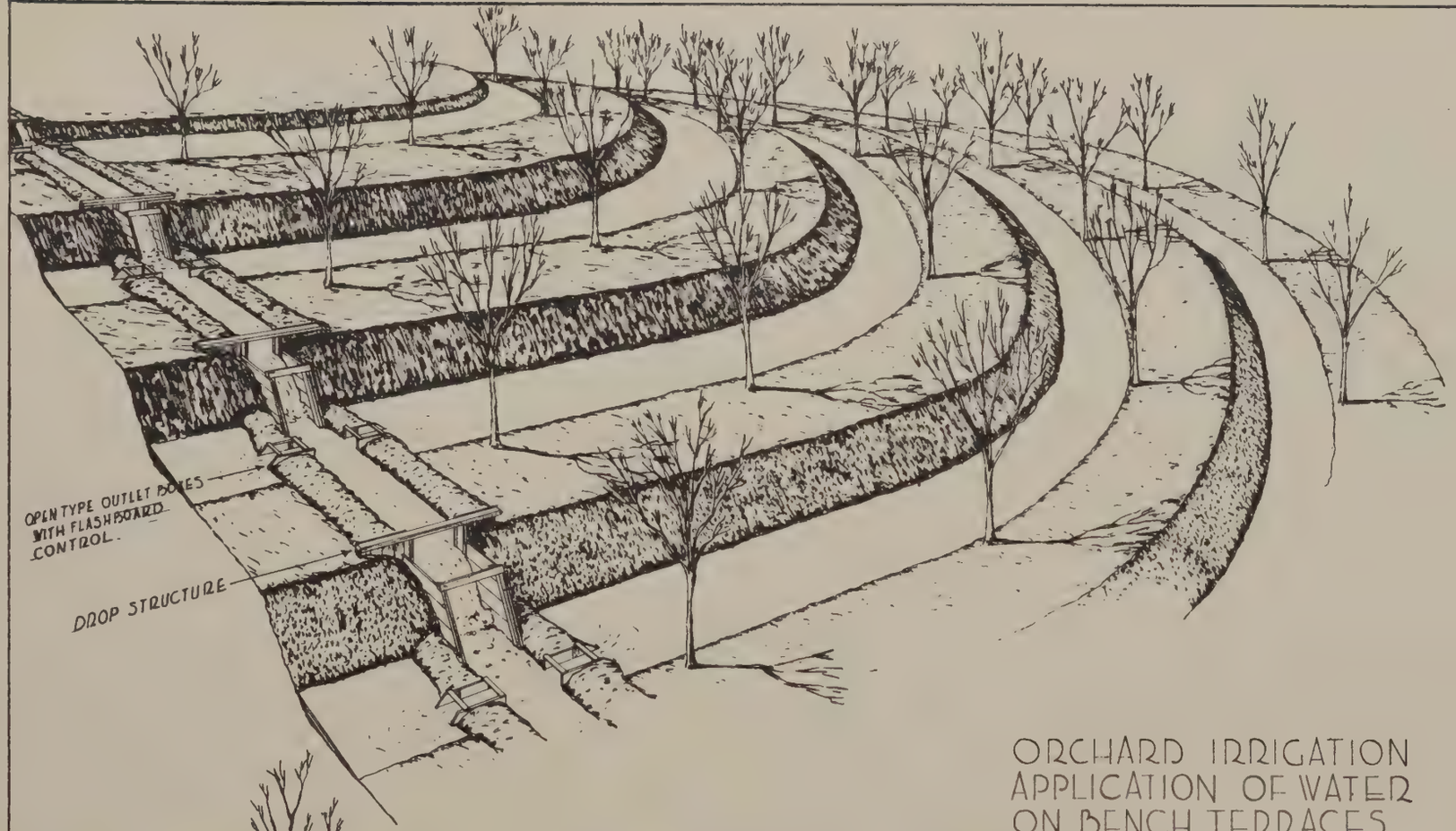
THE PLANTING OF ORCHARD ROWS APPROXIMATELY ON THE CONTOUR INCREASES THE EFFICIENCY WITH WHICH IRRIGATION WATER MAY BE APPLIED AND ELIMINATES A SERIOUS EROSION PROBLEM. IN SOME CASES UNDERGROUND PIPE LINES HAVE BEEN INSTALLED TO DELIVER WATER TO FURROWS AS SHOWN IN THE SKETCH.

THE SUPPLY FROM THE PIPE LINE TO THE SMALL STILLING BASIN IS CONTROLLED BY A VALVE WHICH IS HAND OPERATED. THE DIVISION OF THE FLOW TO THE FURROWS IS MADE FROM A FIELD LATERAL BY MEANS OF SMALL CHECK DAMS AND LATH BOXES.

THE FURROWS BETWEEN TREE ROWS MAY BE MADE WITH THE "TORPEDO" TYPE FURROW OPENER SHOWN ON SHEET 25.

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER COLORADO	IRRIGATION STRUCTURES		F. 313-27 D. 3-26-43
Des. WOOD	Dr. MOORE	Tr. MOORE	Ck.

FIG. 15



ORCHARD IRRIGATION APPLICATION OF WATER ON BENCH TERRACES.

DIAGRAMATIC SECTION THRU SLOPE

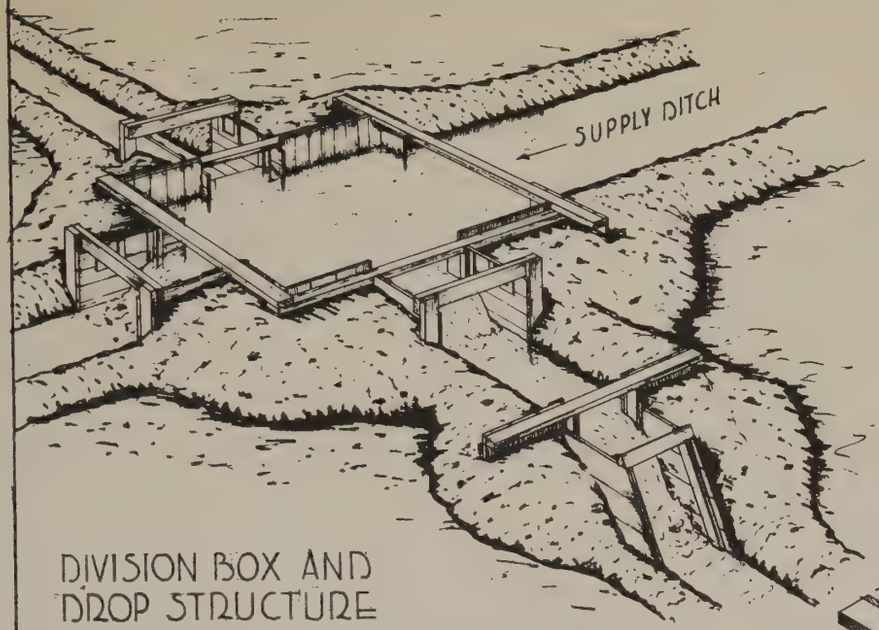
THE PLANTING OF ORCHARDS ON CONTOUR BENCH TERRACES ON STEEP SLOPES PREVENTS EROSION AND SAVES LABOR IN APPLYING IRRIGATION WATER. THE WIDTH OF BENCHES DEPENDS ON THE SPACING OF TREE ROWS AND SOMEWHAT ON THE SLOPE.

IRRIGATION WATER MAY BE SUPPLIED BY A CANAL PROVIDED WITH A SERIES OF DROPS AND OUTLET BOXES OR BY MEANS OF A PIPE LINE. EACH "BENCH" MAY BE SLOPED SLIGHTLY TOWARD THE HILL TO PROVIDE A CHANNEL OR A SERIES OF FURROWS MAY BE USED AS SHOWN ON SHEET 15.

CARE MUST BE USED TO PROVIDE A PROTECTED CHANNEL FOR REMOVAL OF EXCESS IRRIGATION WATER OR SERIOUS EROSION MAY RESULT.

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER	IRRIGATION		F. 313:26
COLORADO	STRUCTURES		D. 3-25-43
Des. WOOD	Dr. MOORE	Tr. MOORE	Ck

FIG. 16



DIVISION BOX AND DROP STRUCTURE IN PLACE -

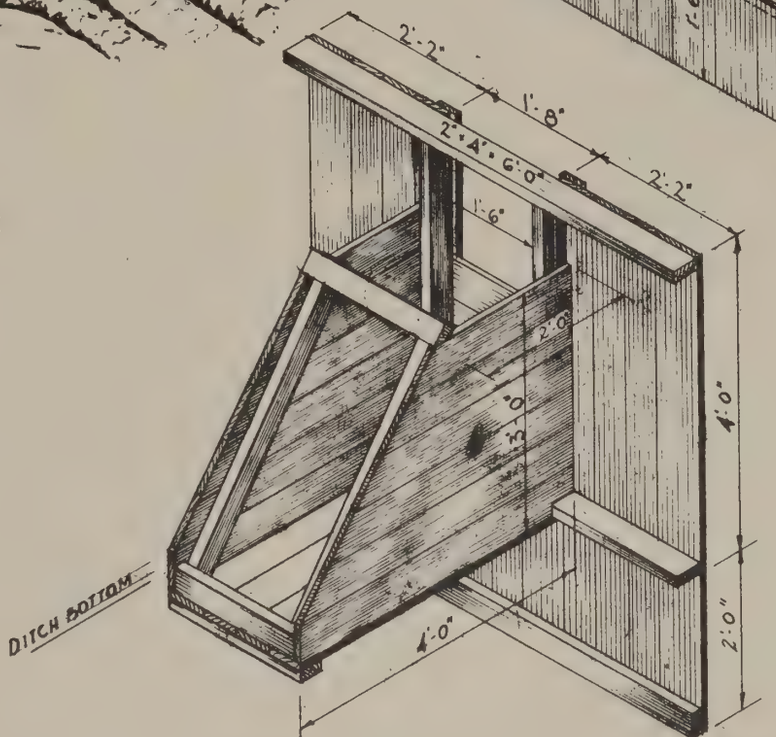
MATERIAL LISTS

DIVISION BOX —

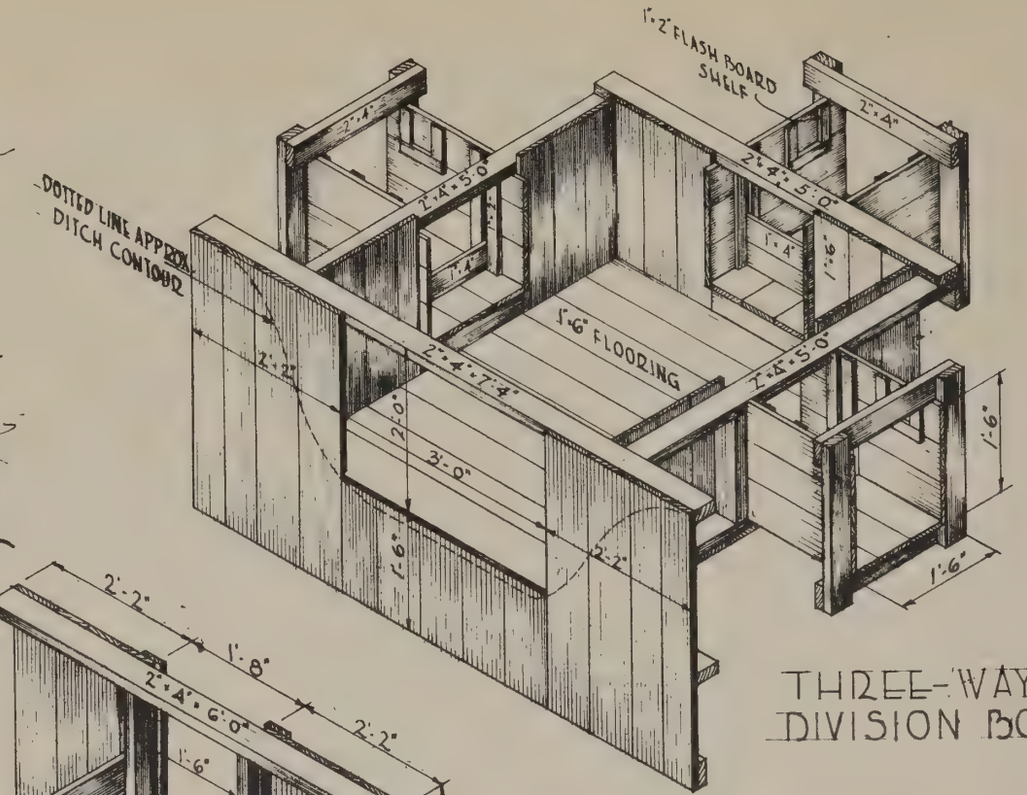
5 PCS. 2" × 4" × 7'-4" SUPPLY DITCH BLK'HD.
6 PCS. 2" × 4" × 5'-0" SIDE WALL TIES.
18 PCS. 2" × 4" × 2'-2" OUTLET CHUTE TIES.
20 PCS. 1" × 6" × 10'-0" WALLS & FLOOR.
3 PCS. 1" × 8" × 10'-0" " " "
12 PCS. 1" × 4" × 1'-6" FLASHBOARDS
30 L.F. 1" × 2" FLASHBOARD SLIDES & SHELF.

DROP STRUCTURE —

3 PCS. 2" × 4" × 6'-0" BLK-HD. SUPPORTS.
2 PCS. 2" × 4" × 4'-0" " TO CHUTE
2 PCS. 2" × 4" × 5'-0" SIDES OF CHUTE LIP
3 PCS. 2" × 4" × 2'-4" CHUTE BRACES.
6 PCS. 1" × 6" × 6'-0" BULK-HEAD
2 PCS. 1" × 8" × 6'-0" " "
5 PCS. 1" × 6" × 8'-0" CHUTE FLOOR & SIDES
6 PCS. 1" × 6" × 1'-8" FLASHBOARDS
2 PCS. 1" × 4" × 4'-0" FLASHBOARD GUIDES.



DROP STRUCTURE FOR LATERAL



THREE-WAY DIVISION BOX

STRUCTURES FOR IRRIGATION LATERALS

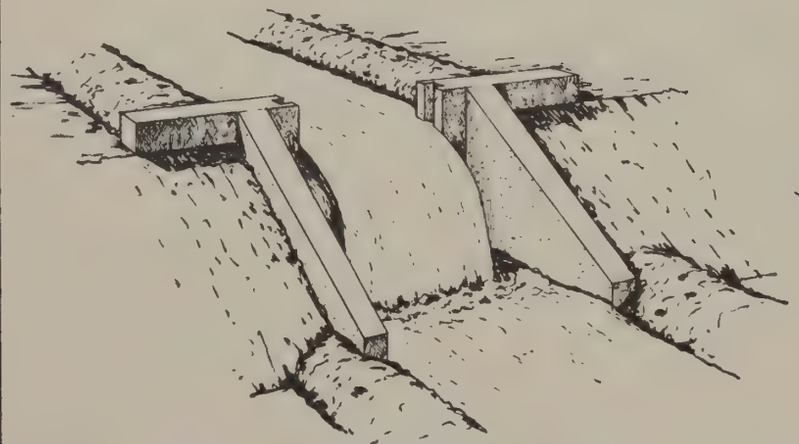
THE DIVISION BOX AND THE DROP STRUCTURE ARE IMPORTANT FEATURES OF THE FARM IRRIGATION SYSTEM. THOSE SHOWN ARE MADE OF CREOSOTED LUMBER AND WHILE NOT AS PERMANENT AS IF BUILT OF MASONRY HAVE THE ADVANTAGE OF BEING MORE OR LESS PORTABLE.

WET EARTH MUST BE TIGHTLY COMPACTED AROUND THE WALLS OF ALL STRUCTURES BUILT IN IRRIGATION CANALS AND LATERALS OR UNDERCUTTING IS SURE TO RESULT.

THE BANKS OF SMALL LATERALS AND CANALS MAY BE PLOWED IN FROM TIME TO TIME AND REBUILT TO DESTROY WEEDS AND HARBORING PLACES FOR INSECT PESTS.

USDA	FARM SECURITY ADMINISTRATION	USDA
DENVER COLORADO	IRRIGATION STRUCTURES	F. 313: 25 D. 3-24-43
Des. WOOD	Dr. MOORE	Tr. MOORE	Ck.

FIG. 17



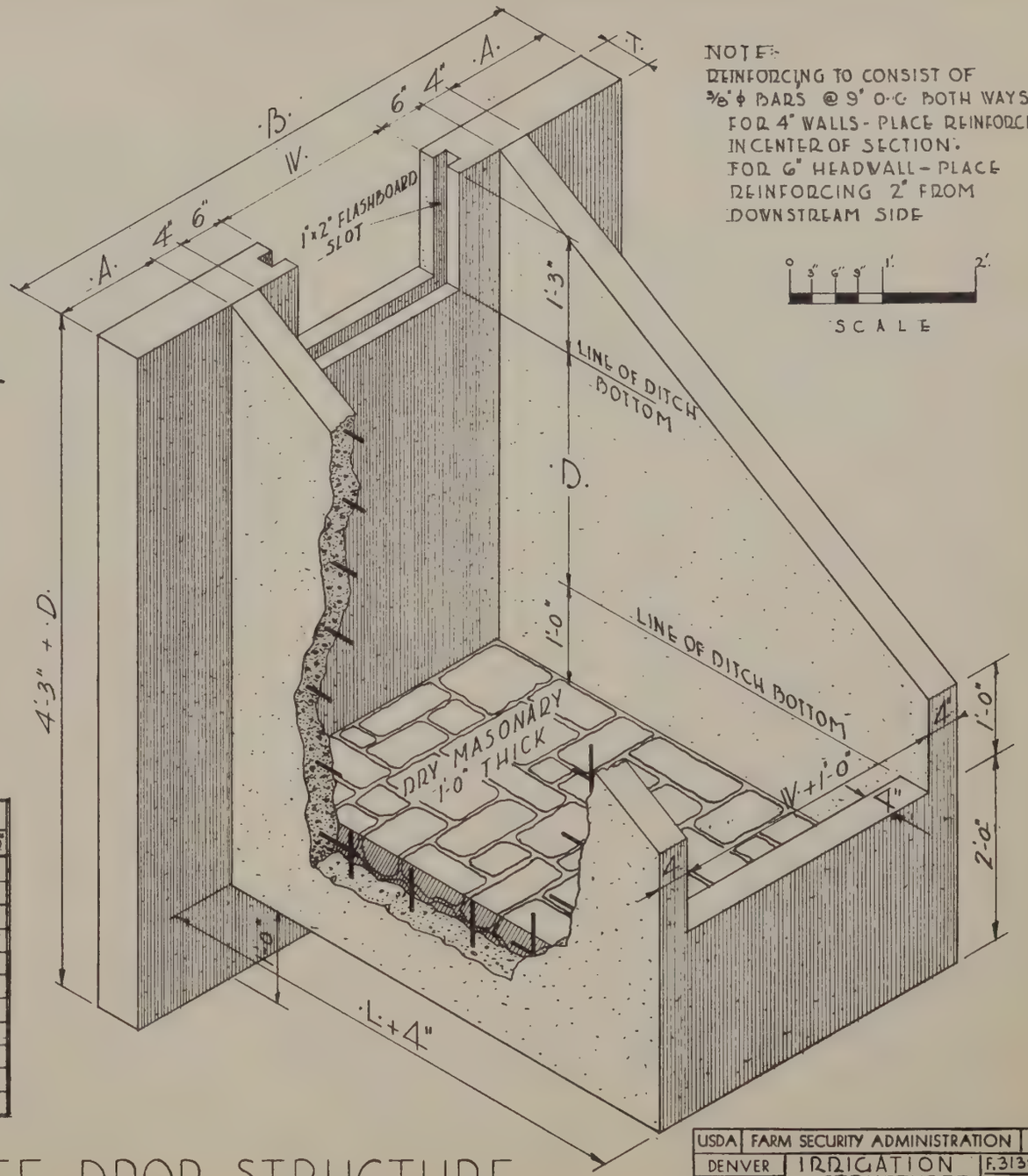
DROP STRUCTURE IN PLACE

IF DROPS ARE CONSTRUCTED OF RUBBLE MASONRY INSTEAD OF CONCRETE AS SHOWN, THE WALLS MUST BE HEAVIER AND CARE MUST BE USED TO "BREAK JOINTS". "HEADERS" SHOULD BE USED TO CONNECT THE HEAD WALL TO THE WING WALLS.

DROPS ARE SPACED SO THAT A NON-EROSIVE GRADE IS MAINTAINED IN THE CANAL BETWEEN STRUCTURES.

SCHEDULE

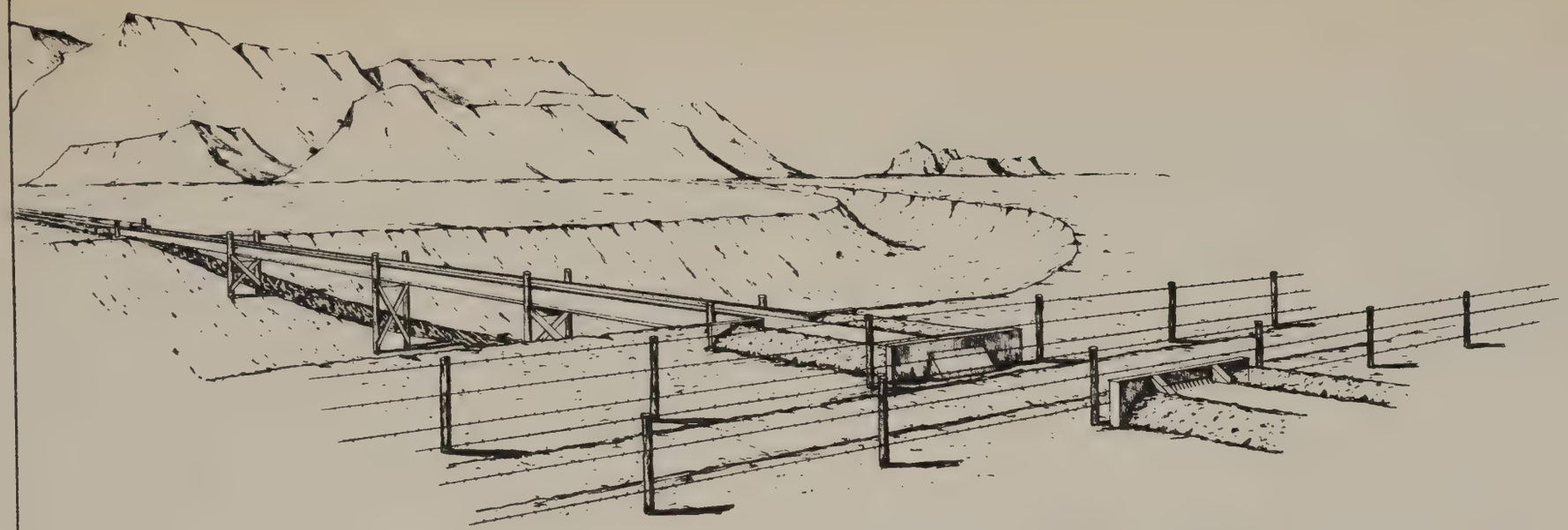
ITEM		D = 2'-0"		D = 3'-0"	
		W = 2'-0"	W = 3'-0"	W = 2'-0"	W = 3'-0"
	A	1'-2"	2'-2"	1'-2"	2'-2"
	B	6'-0"	9'-0"	6'-0"	9'-0"
	L	4'-6"	4'-6"	5'-0"	5'-0"
	T	0'-4"	0'-6"	0'-6"	0'-6"
CUBIC YARDS OF CONCRETE		1.0	1.6	1.5	1.9
SACKS OF CEMENT		6.0	9.6	9.0	11.4
CUBIC YARDS OF SAND		0.75	1.20	1.13	1.43
CUBIC YARDS OF GRAVEL		0.80	1.28	1.20	1.52
FEET OF 3/8" ϕ REINF. BARS		230	255	325	382
CU. FT. DRY MASONRY		13.5	18.0	15.0	20.0
CAP. OF DROP IN C.F.S. 1' DEPTH OF FLOW		6.1	9.1	6.1	9.1



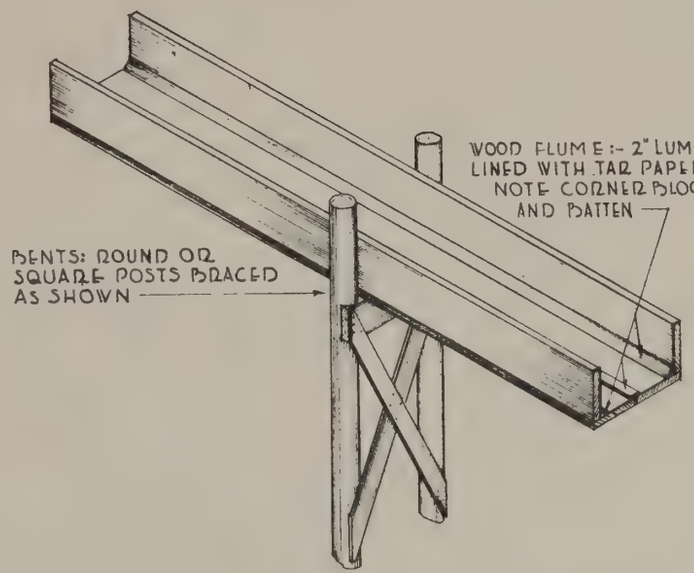
CONCRETE DROP STRUCTURE

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER COLORADO	IRRIGATION STRUCTURES		F.313:28 D. 3-27-43
Des. STOKER	Dr. MOORE	Tr. MOORE	Ck.

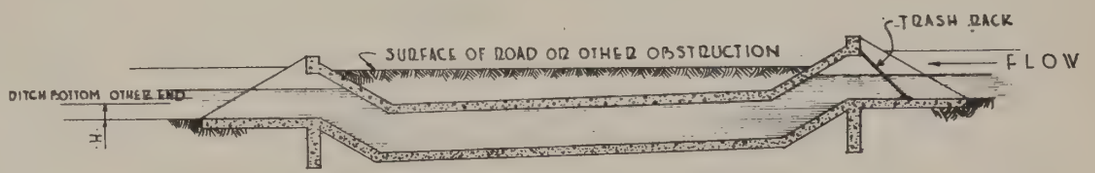
FIG. 18



TRANSPORTING WATER UNDER LANE AND ACROSS GULLY BY USE OF INVERTED SIPHON AND FLUME



ISOMETRIC OF FLUME SECTION

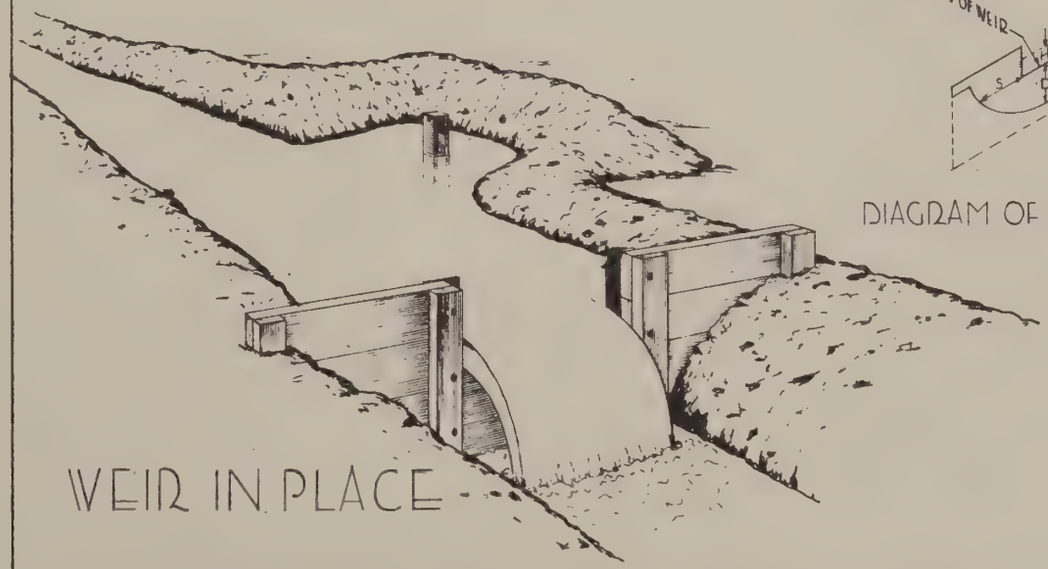


DIAGRAMATIC SECTION OF INVERTED SIPHON

CAPACITY OF SIPHON IS DEPENDENT ON DIAMETER, LENGTH AND KIND OF PIPE, AND DIFFERENCE IN ELEVATION (H)

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER COLORADO	IRRIGATION STRUCTURES		F.313:32 D.4-5-43
Des. STOKER	Dr. MOORE	Tr. MOORE	Ck.

FIG. 19



WEIR IN PLACE

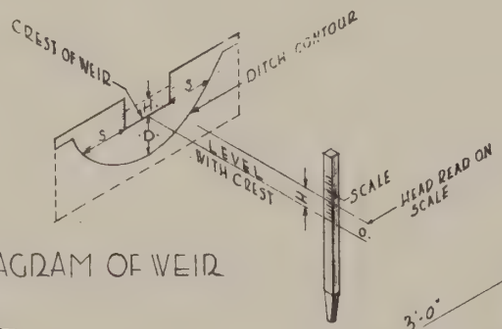
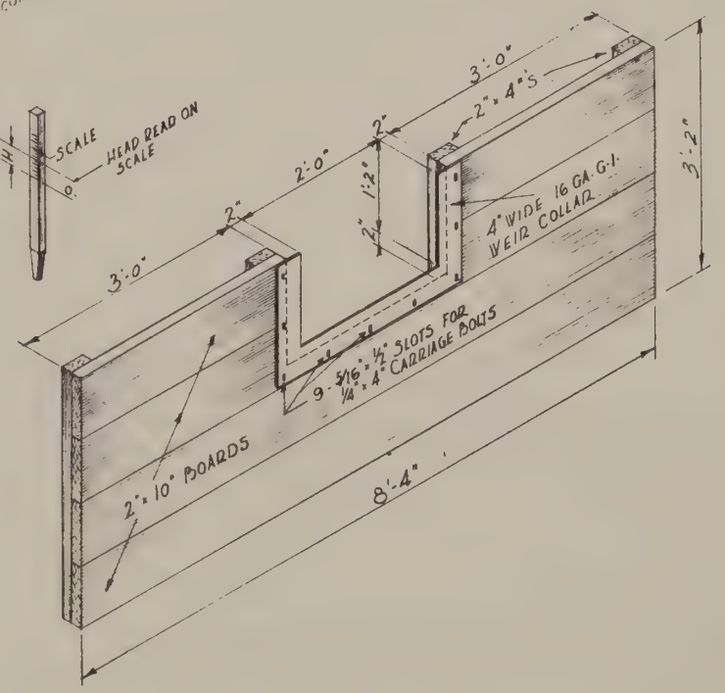
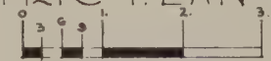


DIAGRAM OF WEIR



ISOMETRIC PLAN OF WEIR



SCALE IN FEET

FLOW OVER RECTANGULAR CONTRACTED WEIR: 2'-0" CREST

HEAD IN FEET	HEAD IN INCHES APPROX.	FLOW IN C.F.S.	FLOW IN GALLONS PER MIN.	HEAD IN FEET	HEAD IN INCHES APPROX.	FLOW IN C.F.S.	FLOW IN GALLONS PER MIN.	HEAD IN FEET	HEAD IN INCHES APPROX.	FLOW IN C.F.S.	FLOW IN GALLONS PER MIN.
0.15	1 13/16	0.385	173	0.39	4 11/16	1.57	705	0.63	7 9/16	3.17	1,420
0.16	1 15/16	0.423	190	0.40	4 13/16	1.63	731	0.64	7 11/16	3.25	1,460
0.17	2 1/16	0.463	208	0.41	4 15/16	1.69	758	0.65	7 13/16	3.32	1,490
0.18	2 3/16	0.504	226	0.42	5 1/16	1.75	785	0.66	7 15/16	3.40	1,520
0.19	2 1/4	0.546	245	0.43	5 3/16	1.81	812	0.67	8 1/16	3.47	1,560
0.20	2 3/8	0.588	264	0.44	5 1/4	1.88	842	0.68	8 3/16	3.56	1,590
0.21	2 1/2	0.632	284	0.45	5 3/8	1.94	870	0.69	8 1/4	3.63	1,630
0.22	2 5/8	0.677	304	0.46	5 1/2	2.00	898	0.70	8 3/8	3.71	1,660
0.23	2 3/4	0.723	325	0.47	5 5/8	2.07	927	0.71	8 1/2	3.78	1,700
0.24	2 7/8	0.769	346	0.48	5 3/4	2.13	956	0.72	8 5/8	3.86	1,730
0.25	3	0.817	367	0.49	5 7/8	2.20	985	0.73	8 3/4	3.94	1,770
0.26	3 1/8	0.865	388	0.50	6	2.26	1,020	0.74	8 7/8	4.02	1,800
0.27	3 1/4	0.914	410	0.51	6 1/8	2.33	1,050	0.75	9	4.10	1,840
0.28	3 3/8	0.965	434	0.52	6 1/4	2.40	1,080	0.76	9 1/8	4.18	1,880
0.29	3 1/2	1.02	457	0.53	6 3/8	2.46	1,110	0.77	9 1/4	4.26	1,910
0.30	3 5/8	1.07	480	0.54	6 1/2	2.53	1,140	0.78	9 3/8	4.34	1,950
0.31	3 3/4	1.12	504	0.55	6 5/8	2.60	1,170	0.79	9 1/2	4.42	1,980
0.32	3 13/16	1.18	528	0.56	6 3/4	2.67	1,200	0.80	9 5/8	4.51	2,020
0.33	3 15/16	1.23	552	0.57	6 13/16	2.74	1,230	0.81	9 3/4	4.59	2,060
0.34	4 1/16	1.28	576	0.58	6 15/16	2.81	1,260	0.82	9 13/16	4.67	2,100
0.35	4 3/16	1.34	601	0.59	7 1/16	2.88	1,290	0.83	9 15/16	4.75	2,130
0.36	4 5/16	1.40	627	0.60	7 3/16	2.96	1,330	0.84	10 1/16	4.84	2,170
0.37	4 7/16	1.45	653	0.61	7 5/16	3.03	1,360				
0.38	4 9/16	1.51	679	0.62	7 7/16	3.10	1,390				

C.F.S. MAY BE READ AS ACRE INCHES PER HOUR.

THE CONTRACTED RECTANGULAR WEIR

THE RECTANGULAR WEIR IS AN EASILY CONSTRUCTED MEASURING DEVICE FOR DETERMINING THE QUANTITY OF WATER USED BY AN IRRIGATOR. UNLESS CERTAIN GENERAL RULES ARE OBSERVED IN ITS USE AND CONSTRUCTION, ACCURATE RESULTS WILL NOT BE OBTAINED.

THE WALL OF THE WEIR SHOULD BE SET PLUMB VERTICALLY AND LEVEL HORIZONTALLY AS WELL AS AT RIGHT ANGLES TO THE DIRECTION OF FLOW OF THE STREAM. IT SHOULD BE SET IN A PORTION OF THE CHANNEL WHICH IS STRAIGHT FOR A DISTANCE OF AT LEAST 25 FEET UPSTREAM. IN ORDER THAT WATER DOES NOT APPROACH THE WEIR AT A VELOCITY OF MORE THAN 1/2 FOOT PER SECOND, IT MAY BE NECESSARY TO WIDEN THE CROSS-SECTION OF THE CHANNEL SOMEWHAT AS SHOWN IN THE DRAWING.

THE HEIGHT OF THE CREST OR BOTTOM OF THE WEIR NOTCH ABOVE THE STREAM BED ON THE UPSTREAM SIDE OF THE WEIR SHOULD BE AT LEAST TWICE THE HEAD TO BE MEASURED. IN OTHER WORDS "D" SHOULD EQUAL 2 x H. THE DISTANCE FROM THE SIDES OF THE WEIR NOTCH TO THE SIDES OF THE BANK SHOULD BE AT LEAST TWICE THE HEAD TO BE MEASURED OR SHOULD BE 2 x H.

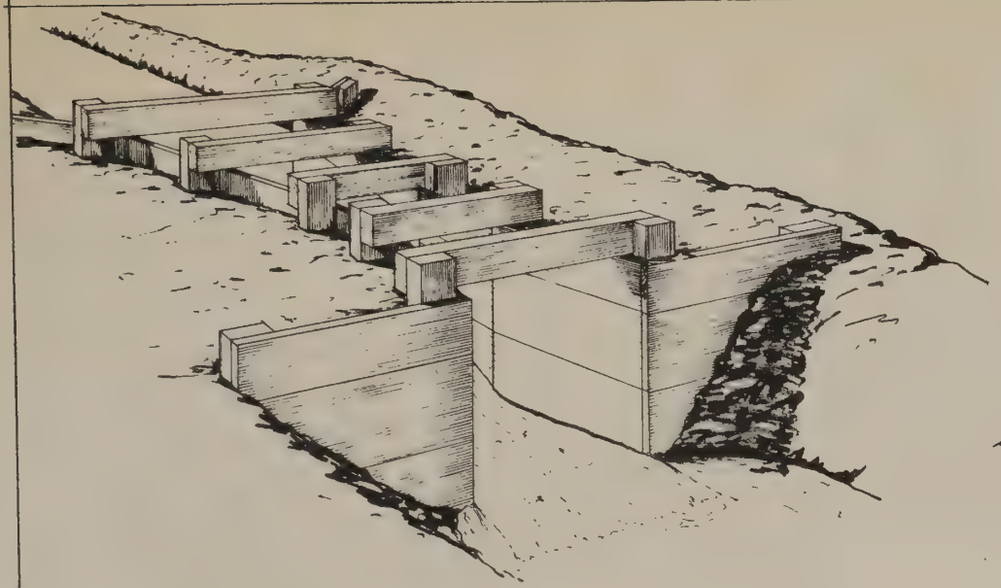
A RULE OR SCALE FOR MEASURING THE HEAD "H" MAY BE ATTACHED TO A STAKE SET AT THE SIDE OF THE CHANNEL AND SOME DISTANCE UPSTREAM. THE "0" POINT ON THE SCALE SHOULD BE SET ON A LEVEL WITH THE WEIR CREST AS SHOWN. THIS MAY BE DONE WITH AN ENGINEERS LEVEL OR A STRAIGHTEDGE AND A CARPENTERS LEVEL.

ORDINARILY THIS TYPE OF WEIR SHOULD NOT BE COMBINED WITH TURN-OUT BOXES, DROPS OR OTHER STRUCTURES FOR BEST RESULTS. A COLLECTION OF SILT ON THE UPSTREAM SIDE OF THE WEIR WILL AFFECT ACCURACY OF RESULTS.

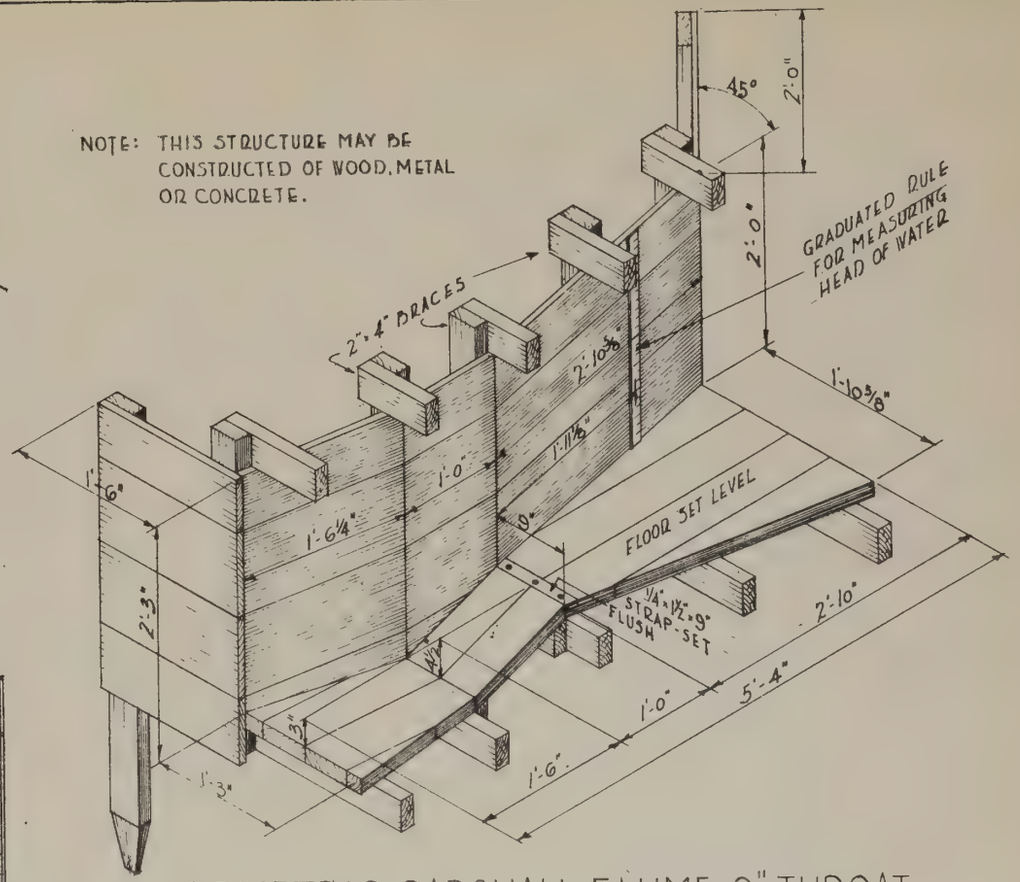
TO MEASURE FLOW OVER THE WEIR, READ THE DEPTH INDICATED ON THE SCALE IN DECIMALS OF A FOOT OR IN INCHES. READ THE FLOW IN CUBIC FEET PER SECOND OR GALLONS PER MINUTE DIRECTLY FROM THE TABLE.

USDA	FARM SECURITY ADMINISTRATION	USDA
DENVER COLORADO	IRRIGATION STRUCTURES	F. 313: 30 D.4-1-43
Des. PIELZCE	Dr. MOORE	Tr. MOORE	Ck.

FIG. 20



NOTE: THIS STRUCTURE MAY BE CONSTRUCTED OF WOOD, METAL OR CONCRETE.



ISOMETRIC: PARSHALL FLUME: 9" THROAT
SIDE REMOVED TO SHOW CONSTRUCTION

SCALE 0 1 2

"FREE-FLOW" THRU A PARSHALL MEASURING FLUME ÷ 9" THROAT

HEAD IN FEET	HEAD IN INCHES APPROX.	FLOW IN C.F.S.	HEAD IN FEET	HEAD IN INCHES APPROX.	FLOW IN C.F.S.	HEAD IN FEET	HEAD IN INCHES APPROX.	FLOW IN C.F.S.	HEAD IN FEET	HEAD IN INCHES APPROX.	FLOW IN C.F.S.
0.10	1 3/16	0.09	0.43	5 3/16	0.84	0.76	9 1/8	2.02	1.09	13 1/16	3.50
0.11	1 5/16	0.10	0.44	5 1/4	0.87	0.77	9 1/4	2.06	1.10	13 3/16	3.55
0.12	1 7/16	0.12	0.45	5 3/8	0.90	0.78	9 3/8	2.10	1.11	13 3/16	3.60
0.13	1 9/16	0.14	0.46	5 1/2	0.94	0.79	9 1/2	2.14	1.12	13 7/16	3.65
0.14	1 11/16	0.15	0.47	5 5/8	0.97	0.80	9 5/8	2.18	1.13	13 9/16	3.70
0.15	1 13/16	0.17	0.48	5 3/4	1.00	0.81	9 3/4	2.22	1.14	13 11/16	3.75
0.16	1 15/16	0.19	0.49	5 7/8	1.03	0.82	9 13/16	2.27	1.15	13 13/16	3.80
0.17	2 1/16	0.20	0.50	6	1.06	0.83	9 15/16	2.31	1.16	13 15/16	3.85
0.18	2 3/16	0.22	0.51	6 1/8	1.10	0.84	10 1/16	2.35	1.17	14 1/16	3.90
0.19	2 1/4	0.24	0.52	6 1/4	1.13	0.85	10 3/16	2.39	1.18	14 3/16	3.95
0.20	2 3/8	0.26	0.53	6 3/8	1.16	0.86	10 5/16	2.44	1.19	14 1/4	4.01
0.21	2 1/2	0.28	0.54	6 1/2	1.20	0.87	10 7/16	2.48	1.20	14 3/8	4.06
0.22	2 5/8	0.30	0.55	6 5/8	1.23	0.88	10 9/16	2.52	1.21	14 1/2	4.11
0.23	2 3/4	0.32	0.56	6 3/4	1.26	0.89	10 11/16	2.57	1.22	14 5/8	4.16
0.24	2 7/8	0.35	0.57	6 13/16	1.30	0.90	10 13/16	2.61	1.23	14 3/4	4.22
0.25	3	0.37	0.58	6 15/16	1.33	0.91	10 15/16	2.66	1.24	14 7/8	4.27
0.26	3 1/8	0.39	0.59	7 1/16	1.37	0.92	11 1/16	2.70	1.25	15	4.32
0.27	3 1/4	0.41	0.60	7 3/16	1.40	0.93	11 3/16	2.75	1.26	15 1/8	4.37
0.28	3 3/8	0.44	0.61	7 5/16	1.44	0.94	11 1/4	2.79	1.27	15 1/4	4.43
0.29	3 1/2	0.46	0.62	7 7/16	1.48	0.95	11 3/8	2.84	1.28	15 3/8	4.48
0.30	3 5/8	0.49	0.63	7 9/16	1.51	0.96	11 1/2	2.88	1.29	15 1/2	4.53
0.31	3 3/4	0.51	0.64	7 11/16	1.55	0.97	11 5/8	2.93	1.30	15 5/8	4.59
0.32	3 13/16	0.54	0.65	7 13/16	1.59	0.98	11 3/4	2.98	1.31	15 3/4	4.64
0.33	3 15/16	0.56	0.66	7 15/16	1.63	0.99	11 7/8	3.02	1.32	15 13/16	4.69
0.34	4 1/16	0.59	0.67	8 1/16	1.66	1.00	12	3.07	1.33	15 15/16	4.75
0.35	4 3/16	0.62	0.68	8 3/16	1.70	1.01	12 1/8	3.12	1.34	16 1/16	4.80
0.36	4 5/16	0.64	0.69	8 1/4	1.74	1.02	12 1/4	3.17	1.35	16 3/16	4.86
0.37	4 7/16	0.67	0.70	8 3/8	1.78	1.03	12 3/8	3.21	1.36	16 5/16	4.92
0.38	4 9/16	0.70	0.71	8 1/2	1.82	1.04	12 1/2	3.26	1.37	16 7/16	4.97
0.39	4 11/16	0.73	0.72	8 5/8	1.86	1.05	12 5/8	3.31	1.38	16 9/16	5.03
0.40	4 13/16	0.76	0.73	8 3/4	1.90	1.06	12 3/4	3.36	1.39	16 11/16	5.08
0.41	4 15/16	0.78	0.74	8 7/8	1.94	1.07	12 13/16	3.40	C.F.S. MAY BE READ AS ACRE INCHES PER HOUR		
0.42	5 1/16	0.81	0.75	9	1.98	1.08	12 15/16	3.45			

NOTE: GALS. PER MIN. = C F S × 448.83

MATERIAL LIST

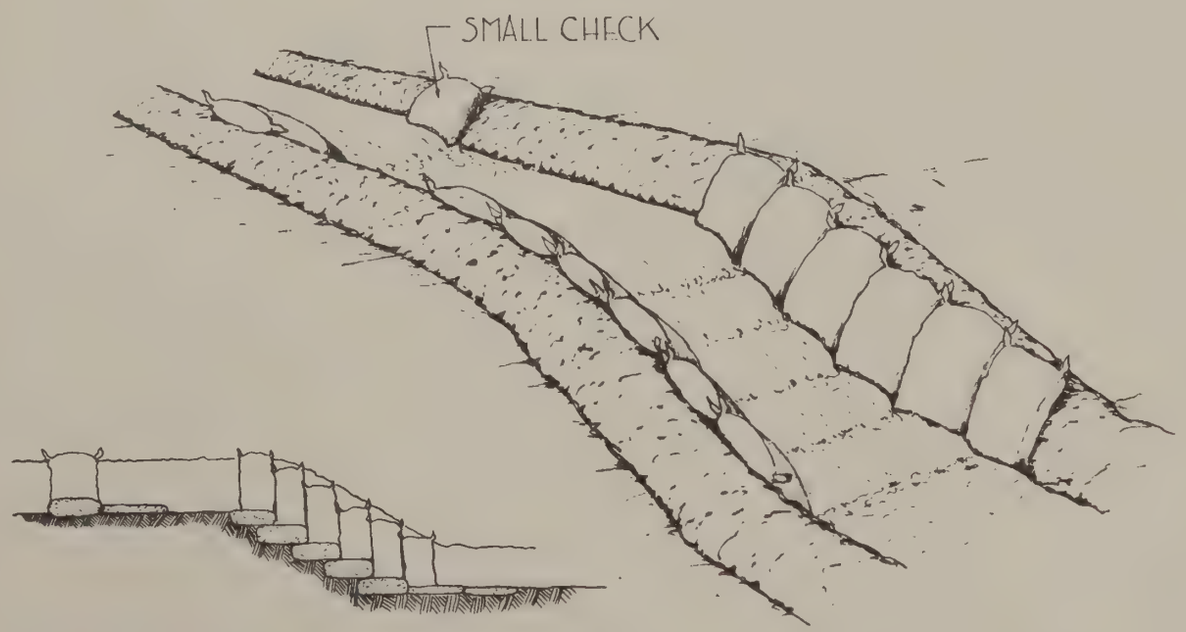
FLOOR:	2 PCS.	2" × 6" × 8'-0"
	1 PC.	2" × 6" × 6'-0"
SIDE WALLS:	4 PCS.	1" × 10" × 8'-0"
	2 PCS.	1" × 6" × 8'-0"
	1 PC.	1" × 4" × 6'-0"
WINGS:	3 PCS.	1" × 10" × 8'-0"
	1 PC.	1" × 6" × 8'-0"
BRACES:	8 PCS	2" × 4" × 10'-0"
STRAP IRON CREST PC.		¼" × 1½" × 9"
GRADUATED RULE		24" LONG - ENAMELED STEEL PREFERABLE

THE PARSHALL FLUME IS A COMMONLY USED MEASURING DEVICE FOR DETERMINING THE QUANTITY OF WATER FLOWING IN A CANAL OR LATERAL. IT SHOULD BE LOCATED IN THE CENTER OF THE CHANNEL WITH THE UPPER FLOOR SET LEVEL. DIRT SHOULD BE THOROUGHLY TAMPED AROUND IT OR UNDERCUTTING WILL RESULT.

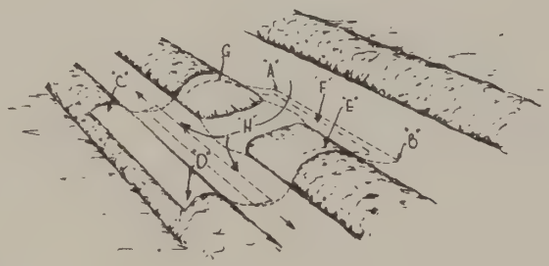
TO MEASURE THE QUANTITY OF WATER FLOWING THROUGH THE FLUME READ THE DEPTH OF WATER ON THE RULE OR SCALE IN DECIMALS OF A FOOT OR IN INCHES. THEN FROM THE TABLE READ THE FLOW IN CUBIC FEET PER SECOND. TO CONVERT TO GALLONS PER MINUTE MULTIPLY CUBIC FEET PER SECOND BY 448.83.

USDA	FARM SECURITY ADMINISTRATION	USDA
DENVER COLORADO	IRRIGATION STRUCTURES	F. 313:31 D.4-2-43
Des. PIERCE	Dr. MOORE	Tr. MOORE	Ck.

FIG. 21



SECTION LARGE DROP STRUCTURE



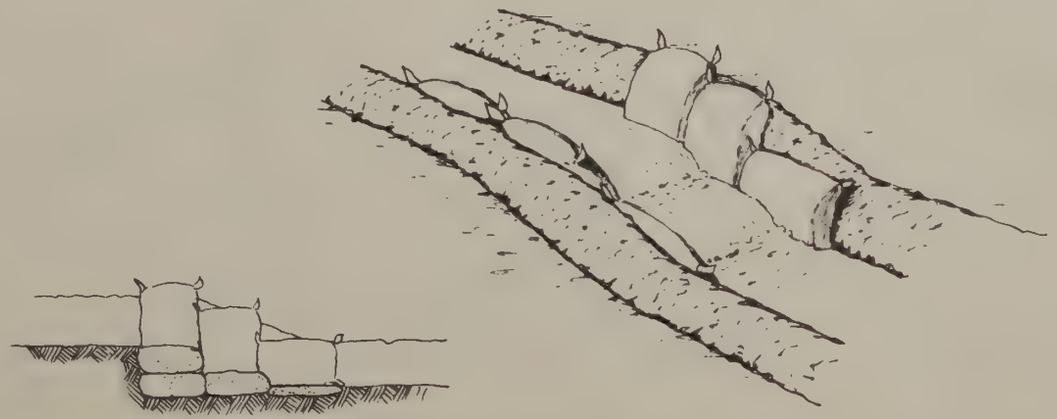
SACKS: TO FORM DITCH TURNOUT

USE OF GUNNY SACKS AS EMERGENCY STRUCTURES

EXPERIENCED IRRIGATORS FIND IT VERY HELPFUL TO USE GUNNY SACKS IN BUILDING EMERGENCY STRUCTURES. BY FILLING SACKS WITH SAND OR COARSE SANDY SOIL DROPS OF ALL SIZES MAY BE MADE AS WELL AS SMALL CHECKS. EMERGENCY REPAIRS TO CANAL OR LATERAL BANKS CAN BE ACCOMPLISHED WITH SAND BAGS WITHOUT INTERRUPTING THE FLOW.

A CONVENIENT AND FAIRLY PERMANENT CANAL TURNOUT CAN BE MADE WITH GUNNY SACKING MATERIAL AS SHOWN ABOVE. THE FOLLOWING STEPS ARE NECESSARY TO ASSURE SUCCESS:

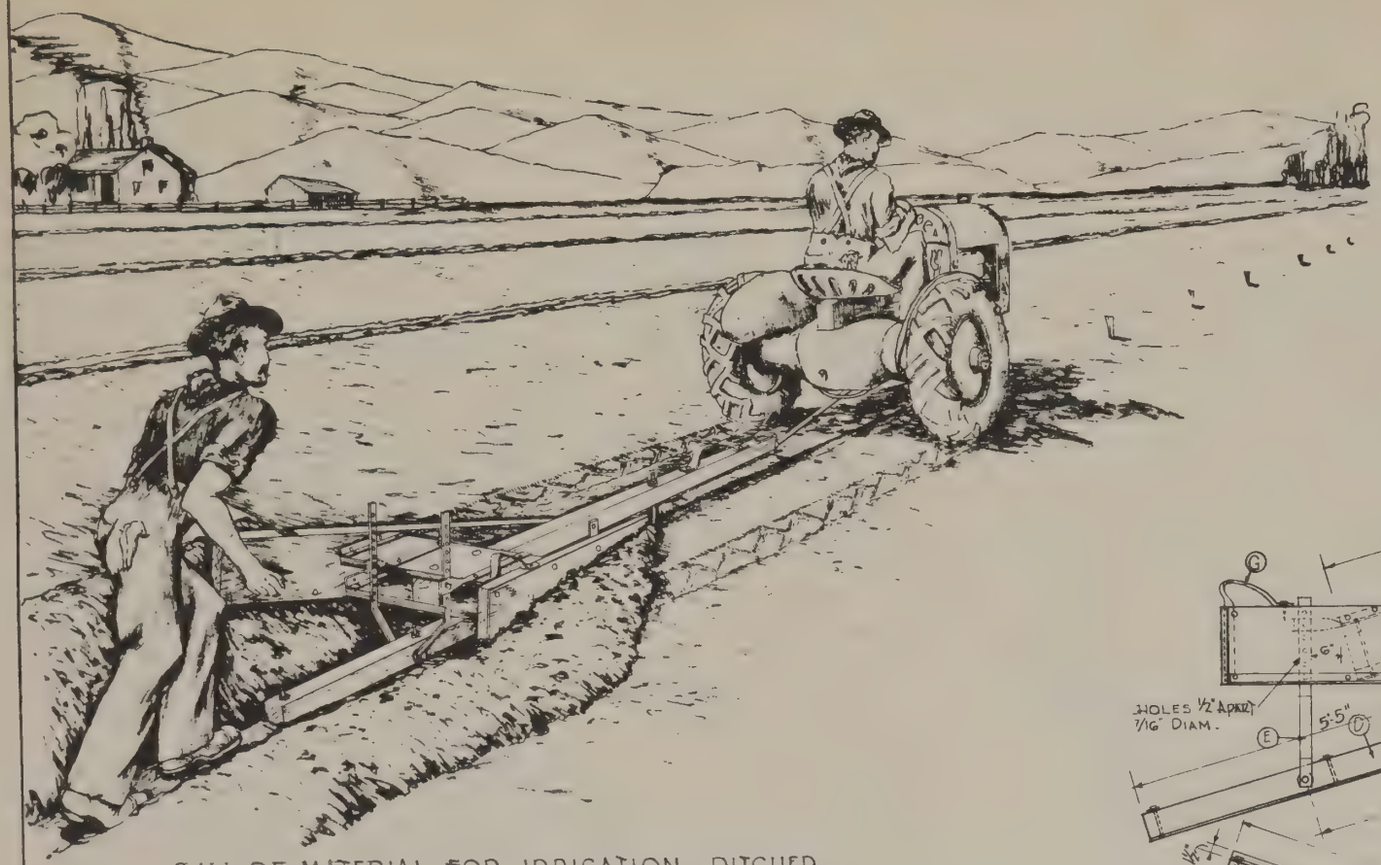
1. WET THE SQUARE OF SACK MATERIAL AND SPREAD ON THE DITCH BANK AS SHOWN ABOVE AT "A-B-C-D".
2. USING THE POINT OF THE IRRIGATION SHOVEL, STARTING AT "E" PUSH THE EDGE OF THE SACKING FIRMLY INTO THE MUD AS SHOWN BY DOTTED LINE "E-F-G".
3. RAISE THE EDGE OF THE SACKING "C-D" IN THE LEFT HAND AND WITH THE SHOVEL REMOVE DIRT FROM THE DITCH BANK AT "H".
4. PAT THE SACKING AT "H" UNTIL SUFFICIENT FLOW PASSES OVER IT. THE VOLUME OF FLOW MAY BE CONTROLLED BY RAISING AND LOWERING THE SACKING AT "H" EITHER BY USING A SHOVEL FULL OF DIRT OR A FOLDED PIECE OF SACKING.
5. THE EDGE OF THE SACKING "C-D" IS PUT IN POSITION AS SHOWN TO PREVENT EROSION OF THE DITCH BANK.

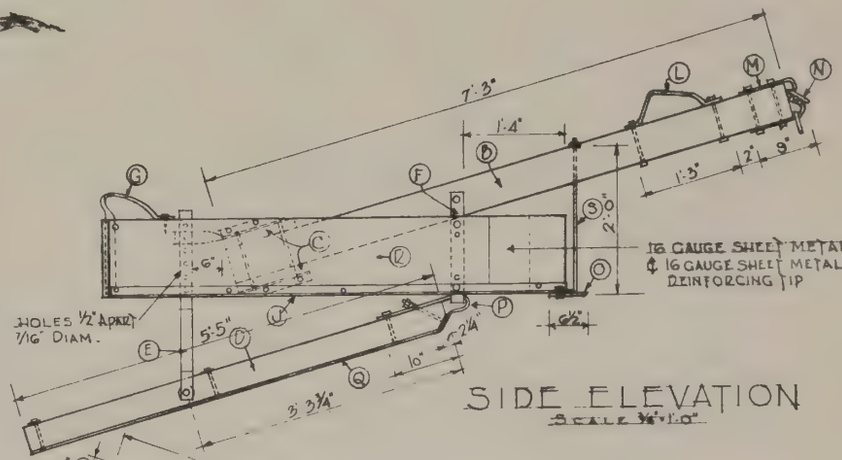


SECTION SMALL DROP STRUCTURE

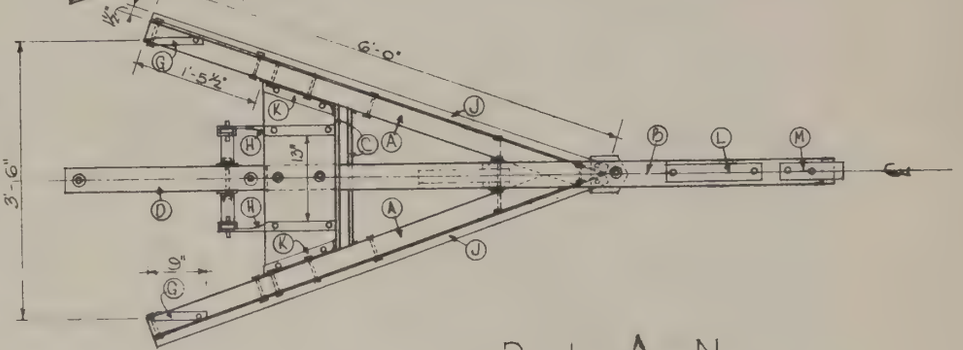
USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER COLORADO	IRRIGATION STRUCTURES		F.313:40 D.4-20-43
Des. WOOD	Dr. MOORE	Tr. MOORE	Ck.

FIG. 22





SIDE ELEVATION
SCALE ¾"=1'-0"



PLAN
SCALE ¾"=1'-0"

BILL OF MATERIAL FOR IRRIGATION DITCHER

WOOD

- (A) 2 - 3" × 12" × 6'-0" BRIDGE PLANK - (SIDES)
- (B) 1 - 4" × 6" × 8'-0" HICKORY OR OAK - (TONGUE)
- (C) 2 - 2" × 12" × 2'-6" PINE SPREADERS
- (D) 1 - 4" × 4" × 6'-0" HICKORY OR OAK - (SKID)

IRON

- (E) 2 - ½" × 1½" × 3'-0" STRAP IRON (HEIGHT ADJUSTERS)
- (F) 1 - ½" × 2" × 3'-4" STRAP IRON (SKID SUPPORT)
- (G) 2 - ½" × 1½" × 2'-0" STRAP IRON (HANDLES)
- (H) 2 - ½" × 1½" × 1'-9" STRAP IRON (HEIGHT ADJUSTER CHECKS)
- (J) 2 - 1½" × 1½" × 6'-0" ANGLE IRON (SIDE SHOES)
- (K) 4 - 1½" × 1½" × 1'-0" ANGLE IRON (SPREADER SUPPORTS)
- (L) 1 - ½" × 2½" × 1'-8" STRAP IRON
- (M) 1 - ½" × 2½" × 2'-6" STRAP IRON (CLEVIS)
- (N) 2 - ⅜" × 4" DIAM. RINGS (CLEVIS)
- (O) 1 - ⅜" × 5" × 6½" FLAT PLATE
- (P) 1 - ½" × 2" × 1'-8" STRAP IRON (SKID CLEVIS)
- (Q) 1 - ⅜" × 4" × 5'-6" STRAP IRON (SKID SHOE)
- (R) 2 - 12" × 6'-0" # 16 GAUGE GALV. IRON (SIDE PROTECTION)
  1 - 12" × 2'-0" # 16 GAUGE REINFORCING TIP

BOLTS

- (S) 1 - ¾" × 24"
  2 - 5/16" × 1½" "U" PIECE ELEVATOR (E)
  2 - 5/16" × 7" TONGUE CLEVIS (M) TO (B)
  2 - ⅜" × 7" TONGUE SKID (L) TO (D)
  2 - ⅜" × 9¾" - TONGUE, TO CROSSBOARDS (C)
  4 - 5/16" × 3" ELEVATOR GUIDES (E) TO CROSSBOARDS (C)
  8 - ¼" × 2¼" - ANGLE IRON (K) TO CROSSBOARDS (C)
  10 - ¼" × 3¼" - 8 FROM ANGLE IRON (K) TO BEAM (A)
  2 FOR TOP BOLTS IN HANDLES
  4 - ⅜" × 4½" - BOTTOM SKID (Q) TO BEAM (A)
  6 - ⅜" × 3½" - ANGLE IRON (J) TO BEAM (A)
  2 - ⅜" × 1" - TRIANGULAR PLATE (O) TO ANGLE IRON (J)
  4 - ⅜" × 4" - FRONT "U" IRON (F) TO BEAM (A)
  1 - ⅜" × 6" - FRONT "U" IRON (F) TO TONGUE (B)
  2 - ⅜" × 12" - COLLAR TIE FOR BEAMS (A)
  1 - ⅜" × 5" - "U" PIECE ELEVATOR (E) TO SKID (D)
  2 - ⅜" × 2" - LAG SCREWS FOR HANDLES.

WASHERS

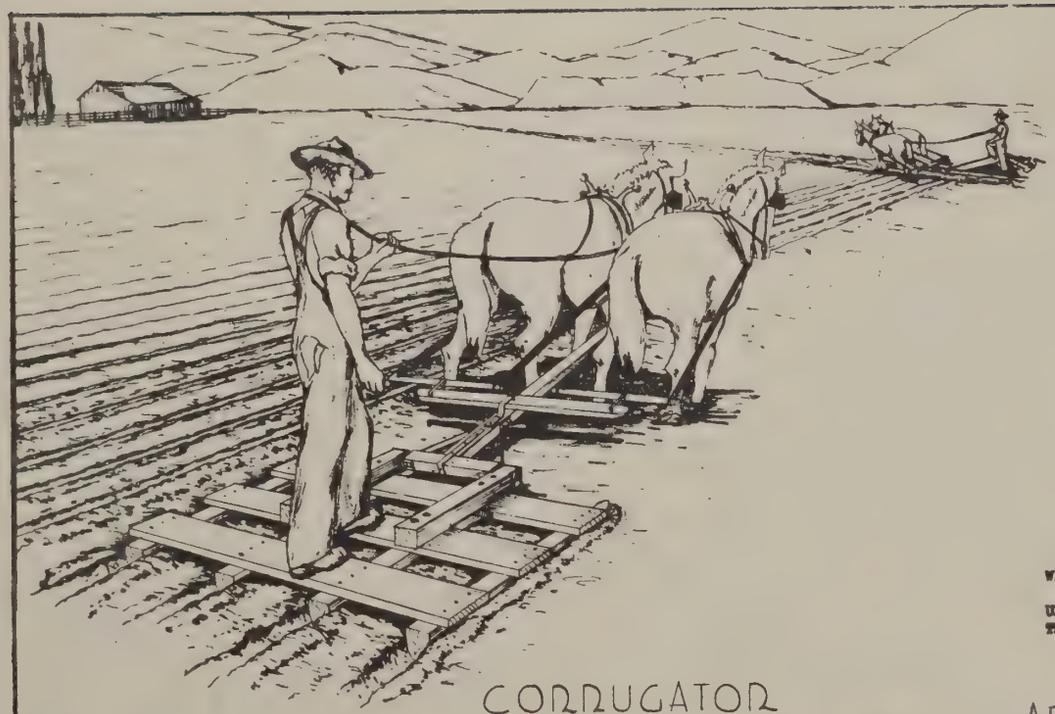
16 FOR ¼" BOLTS
4 FOR 5/16" BOLTS
18 FOR ⅜" BOLTS

NAILS

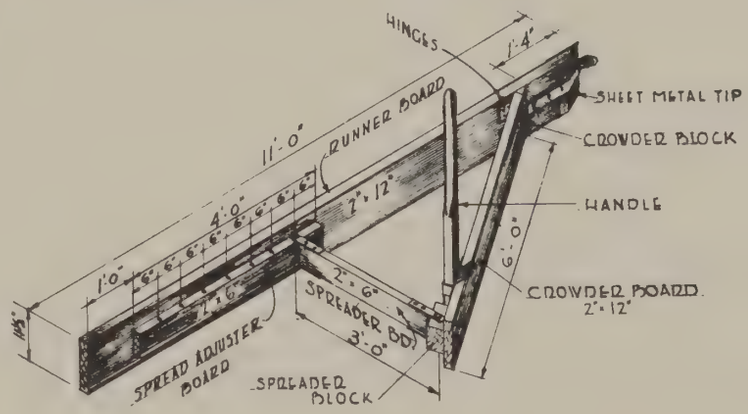
APPROXIMATELY 100 - 8 PENNY WIRE
6 - LARGE SPIKES

IRRIGATION DITCHER

USDA	FARM SECURITY ADMINISTRATION	USDA
DENVER COLORADO	IRRIGATION STRUCTURES	F. — D. 9/16/42
Des. WOOD	Dr. MOORE	Tr.	Ck. PIERCE



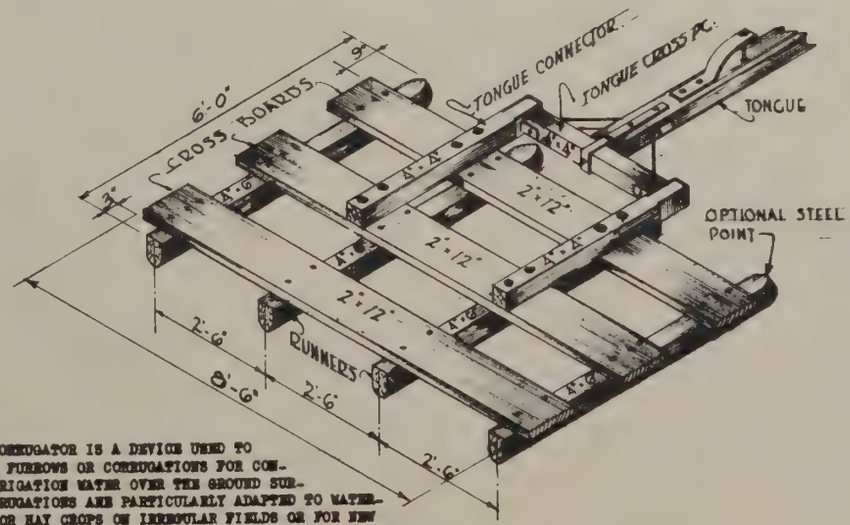
ADJUSTABLE CROWDER



THE ADJUSTABLE CROWDER IS ESSENTIALLY A ONE-WAY IRRIGATION DITCHER. IT IS ADAPTED TO MAKING VARIOUS WIDTH DITCHES BY ADJUSTING THE SPREADER BOARD BETWEEN THE RUNNER AND CROWDER.

SEVERAL FURROWS ARE FIRST PLOWED TO LOOSEN THE DIRT. THEN THE CROWDER WITH THE CROWDER BOARD LEANING UPWARD AND OUTWARD CROWDS THE DIRT TO ONE SIDE TO FORM THE DITCH BANK. THIS OPERATION IS THEN REPEATED ON THE OPPOSITE SIDE TO FORM THE OTHER BANK.

CORRUGATOR



THE CORRUGATOR IS A DEVICE USED TO MAKE SMALL FURROWS OR CORRUGATIONS FOR CONDUCTING IRRIGATION WATER OVER THE GROUND SURFACE. CORRUGATIONS ARE PARTICULARLY ADAPTED TO WATERING GRAIN OR HAY CROPS ON IRREGULAR FIELDS OR FOR NEW FIELDS WHICH HAVE NOT BEEN THOROUGHLY LEVELED AND FLOATED.

THE RUNNERS ARE COMMONLY MADE OF 4" x 6" MATERIAL SPACED 30 INCHES APART. THIS SPACING MAY VARY HOWEVER, DEPENDING ON THE SOIL AND SLOPE OF THE LAND.

MATERIAL LISTS

ADJUSTABLE CROWDER

1 PC. 2" x 12" x 11'-0" RUNNER BOARD
1 PC. 2" x 12" x 6'-0" CROWDER BOARD
1 PC. 2" x 6" x 3'-0" SPREADER BOARD
1 PC. 2" x 6" x 4'-0" SPREAD ADJUSTER BOARD
1 PC. 1½" x 2½" x 4'-6" HARDWOOD HANDLE
1 PC. 4" x 6" x 6" - SPREADER BLOCK
1 PC. ⅜" x 2" x 36" STRAP IRON WITH ¾" END - 2½" DIA. HITCH RING.
2 PCS. ⅜" x 2" x 10" HANDLE SUPPORTS.
4 PCS. ⅜" x 1¾" x 8" SPREADER BOARD ENDS.
1 PC. 12" x 12" HEAVY SHEET METAL CUTTING POINT.
3 - ⅜" x 3" BOLTS - HITCH RING TO RUNNER BD.
3 - ¼" x 4" BOLTS - CROWDER BLK. TO RUNNER BD.
16 - ¼" x 2½" BUTTON HEAD BOLTS FOR HINGES
8 - ¼" x 2½" BOLTS FOR HANDLE SUPPORTS.
4 - ⅜" x 7" " " SPREADER BLOCK
2 - ½" x 7" " " " BOARD BEARINGS
4 - ⅜" x 7" " " " " TIPS.
6 - ½" x 5" " " SPREADER ADJ. BD TO RUNNER.
2 - PCS. 3" SURFACE HINGES.

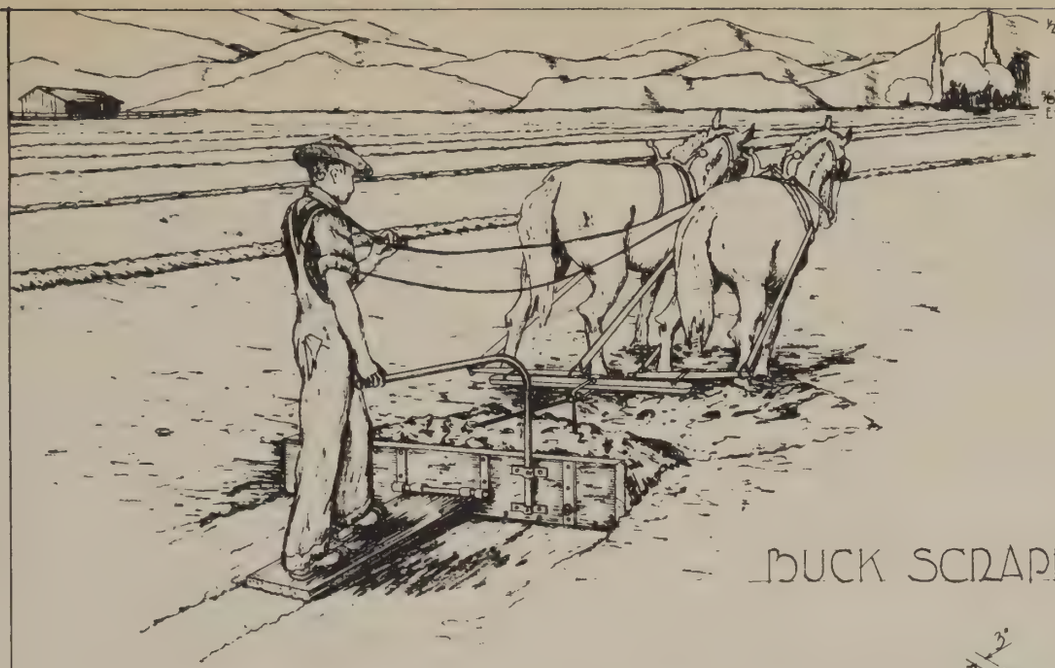
CORRUGATOR

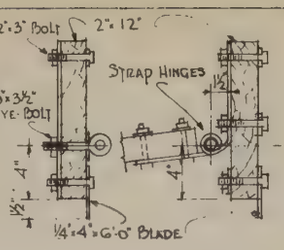
4 PCS. 4" x 6" x 6'-0" FOR RUNNERS
3 PCS. 2" x 12" x 8'-6" FOR CROSS BOARDS
2 PCS. 4" x 4" x 4'-0" FOR TONGUE CONNECTOR
1 PC. 4" x 4" x 2'-10" FOR TONGUE CROSS PC.
1 PC. OLD WAGON TONGUE
1 PC. ¼" x 2½" x 12" STRAP IRON CLEVIS.
1 PC. ¼" x 1½" x 3'-0" " " TONGUE TO CROSS PC.
2 PCS. ¼" x 2" x 3'-0" " " TONGUE BRACES
2 PCS. ¼" x 4" x 1'-4" " " TONGUE CONNECTOR ENDS
1 - ¾" x 8" BOLT - DOUBLE TREE TO CLEVIS
2 - ⅜" x 6" " - CLEVIS TO TONGUE
7 - ½" x 6" " - TONGUE TO CROSS TIE.
1 - ½" x 8" LAG SCREW - CROSS TIE TO TONGUE
2 - ⅝" x 12" " " CONNECTOR TO CROSS TIE AXLE
8 - ⅜" x 8" BOLTS WITH WASHERS - TONGUE CONNECTORS TO CROSS BOARDS.
24 - 5/16" x 8" CGE. BOLTS - HDS. IN RUNNERS - CROSS BOARDS TO RUNNERS.

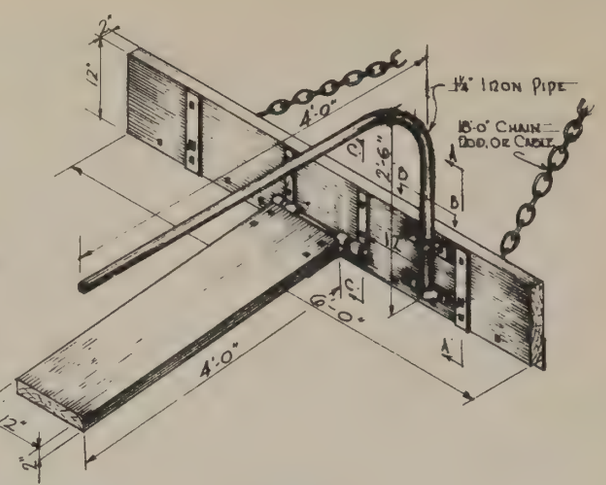
0 3
SCALE IN FEET

USDA	FARM SECURITY ADMINISTRATION	USDA
DENVER	IRRIGATION	F. 313: 20
COLORADO	STRUCTURES	D. 3-12-43
Des. WOOD	Dr. MOORE	Tr. MOORE	Ck.

FIG. 24







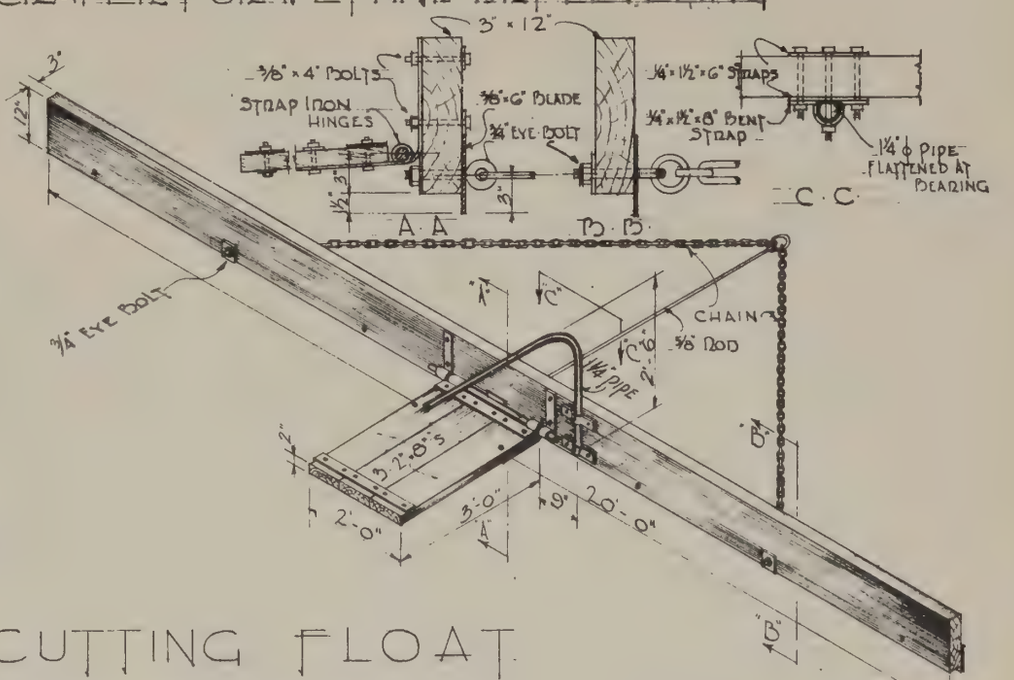
BUCK SCRAPER FOR WET AND DRY LEVELING

BILL OF MATERIAL - "BUCK SCRAPER"

1 - 2" × 12" × 6'-0" = BUCK BOARD
1 - 2" × 12" × 4'-0" - TRAILER BOARD
1 - 1¼" × 6'-6" - IRON PIPE HANDLE
1 - ¼" × 4" × 6'-0" - STRAP IRON CUTTING EDGE
4 - ¼" × 1½" × 12" - STRAP IRON HINGES
2 - ¼" × 2" × 12" - STRAP IRON
2 - ¼" × 1½" × 6" - STRAP IRON --- PIPE CLAMP
2 - ¼" × 1½" × 8" - BENT STRAP IRON " "
1 - ⅝" × 18" - BOLT FOR HINGE
2 - ⅝" × 3½" - EYE-BOLTS
2 - ½" × 5" - CARRIAGE BOLTS
4 - ½" × 4" - " "
22 - ½" × 3" " "
2 - ⅝" WASHERS.
28 - ½" "
18'-0" CHAIN-ROD-OR CABLE HITCH.

BILL OF MATERIAL - "CUTTING FLOAT"

1 - 3" × 12" × 20'-0" BUCK BOARD
3 - 2" × 8" × 3'-0" FOR TRAILER BOARD
1 - ¼" × 6'-0" - IRON PIPE HANDLE
1 - ⅜" × 6" × 20'-0" STRAP IRON CUTTING EDGE
4 - ¼" × 1½" × 12" - STRAP IRON HINGES
2 - ¼" × 3" × 2'-0" - STRAP IRON CLEATS
3 - ¼" × 3" × 3" - FLAT WASHERS
4 - ¼" × 1½" × 6" - STRAP IRON - PIPE CLAMP
2 - ¼" × 1½" × 8" " " " "
1 - ¾" × 2'-6" BOLT FOR HINGE
3 - ¾" × 5" - EYE BOLTS
2 - ½" × 6" - CARRIAGE BOLTS
4 - ½" × 5" " "
14 - ½" × 3" " "
8 - ½" × 4" " "
22 - ½" WASHERS
1 - ⅝"ϕ × 6'-0" ROD FOR HITCH
2 - 9'-0" CHAINS, CABLE OR RODS FOR HITCH
1 - 4" RING FOR HITCH



CUTTING FLOAT

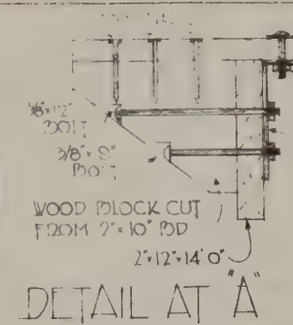
THE BUCK SCRAPER IS A CONVENIENT AND ECONOMICAL IMPLEMENT FOR MOVING EARTH IN LAND LEVELING OPERATIONS. IT IS PARTICULARLY USEFUL IN FILLING LOW SPOTS OR REMOVING HIGH ONES. WHEN DRAWN BY A TEAM OF HORSES IT MAY BE USED WHILE WATER IS BEING APPLIED TO BORDERS. AFTER THE SPACE BETWEEN BORDER DIKES HAS BEEN LEVELED WITH THE FLOAT, WATER MAY BE TURNED IN AND THE LEVELING PROCESS FINISHED AS THE LOW AND HIGH SPOTS ARE REVEALED. THE CUTTING FLOAT IS USED IN SOMEWHAT THE SAME MANNER BUT IS DRAWN WITH TRACTOR POWER AND IS NOT ADAPTED TO WET LEVELING.

USDA	FARM SECURITY ADMINISTRATION	USDA
DENVER COLORADO	IRRIGATION STRUCTURES	F-315-8
Des. WOOD	Dr. MOORE	Ck.

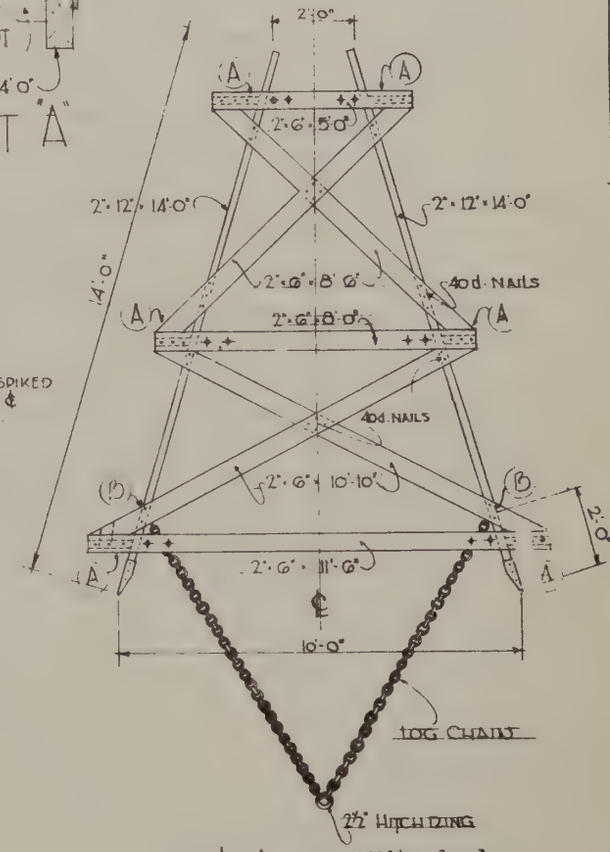
FIG. 25

BILL OF MATERIAL

RUNNERS	2 PCS. 2"×12"×14'-0"
CROSS BRACES	2"×6" - 1 PC. 5'-0" - 1 PC. 8'-0" - 1 PC. 11'-6"
X-BRACES	2"×6" - 2 PCS. 8'-6" - 2 PCS. 10'-10"
BLOCKS	1 PC. 2"×10"×8'-0" CUT BLOCKS TO FIT
BOLTS -	3/8" G - 12" - G - 9" - 12 - 4½" - 2 - 3"
EYE BOLTS	½" - 2 - 3" LONG
WASHERS -	12 - 3/8" - 2 - ½" LARGE BRIDGE TYPE
STRAP IRON	¼"×1½" STRAP - 6 PCS. 18" - 2 PCS. 9"
NAILS -	54 - 40d. SPIKES - SMALL NAILS OR SCREWS FOR RUNNER TIPS
GALV. IRON	2 PCS. 18"×24" - 14 GA. G.I.
CHAIN OR ROD	2 PCS. 8'-0" LONG - LOG CHAIN OR 3/8" ROD.
HITCH RING	1 - 2½" IRON HITCH RING

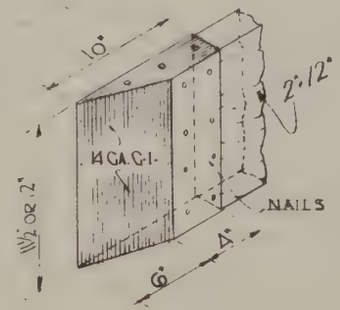


DETAIL AT "A"

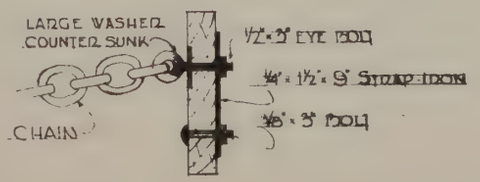


PLAN

NOTE:
X BRACES SPIKED TO RUNNERS & CROSS PCS.



RUNNER TIP



HITCH DETAIL AT "B"

BORDER DRAG

0 1 2 3 4 5 6 7 8 9 10 11 12

DETAIL SCALE IN INCHES

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER COLORADO	IRRIGATION STRUCTURES		F. 51812 D.G./30/42
Dr. WOOD	Dr. MOORE	Tr.	Ck.

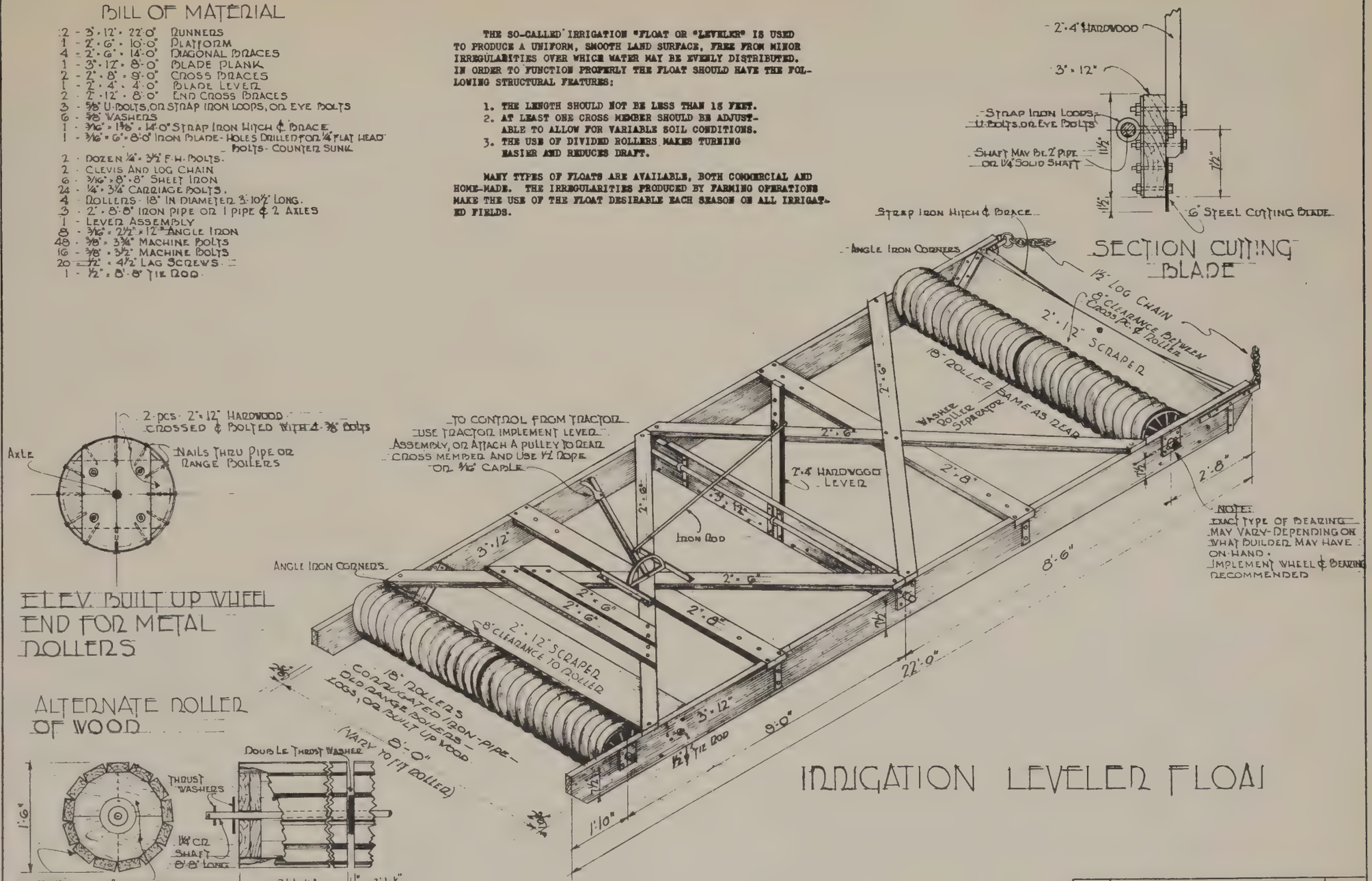
BILL OF MATERIAL

2 - 3" × 12" × 22'-0" RUNNERS
1 - 2" × 6" × 10'-0" PLATFORM
4 - 2" × 6" × 14'-0" DIAGONAL BRACES
1 - 3" × 12" × 8'-0" BLADE PLANK
2 - 2" × 8" × 9'-0" CROSS BRACES
1 - 2" × 4" × 4'-0" BLADE LEVER
2 - 2" × 12" × 8'-0" END CROSS BRACES
3 - 5/8" U-BOLTS, OR STRAP IRON LOOPS, OR EYE BOLTS
6 - 5/8" WASHERS
1 - 3/16" × 1 5/8" × 14'-0" STRAP IRON HITCH ℄ BRACE
1 - 3/16" × 6" × 8'-0" IRON BLADE - HOLES DRILLED FOR 1/4" FLAT HEAD BOLTS - COUNTER SUNK
2 - DOZEN 1/4" × 3 1/2" F.H. BOLTS.
2 - CLEVIS AND LOG CHAIN
6 - 3/16" × 8" × 8" SHEET IRON
24 - 1/4" × 3 1/4" CARRIAGE BOLTS.
4 - ROLLERS - 18" IN DIAMETER 3'-10 1/2" LONG.
3 - 2" × 8'-8" IRON PIPE OR 1 PIPE ℄ 2 AXLES
1 - LEVER ASSEMBLY
8 - 3/16" × 2 1/2" × 12" ANGLE IRON
48 - 3/8" × 3 3/4" MACHINE BOLTS
16 - 3/8" × 3 1/2" MACHINE BOLTS
20 - 1/2" × 4 1/2" LAG SCREWS
1 - 1/2" × 8'-8" TIE ROD

THE SO-CALLED IRRIGATION "FLOAT OR "LEVELER" IS USED TO PRODUCE A UNIFORM, SMOOTH LAND SURFACE, FREE FROM MINOR IRREGULARITIES OVER WHICH WATER MAY BE EVENLY DISTRIBUTED. IN ORDER TO FUNCTION PROPERLY THE FLOAT SHOULD HAVE THE FOLLOWING STRUCTURAL FEATURES:

1. THE LENGTH SHOULD NOT BE LESS THAN 16 FEET.
2. AT LEAST ONE CROSS MEMBER SHOULD BE ADJUSTABLE TO ALLOW FOR VARIABLE SOIL CONDITIONS.
3. THE USE OF DIVIDED ROLLERS MAKES TURNING EASIER AND REDUCES DRAFT.

MANY TYPES OF FLOATS ARE AVAILABLE, BOTH COMMERCIAL AND HOME-MADE. THE IRREGULARITIES PRODUCED BY FARMING OPERATIONS MAKE THE USE OF THE FLOAT DESIRABLE EACH SEASON ON ALL IRRIGATED FIELDS.

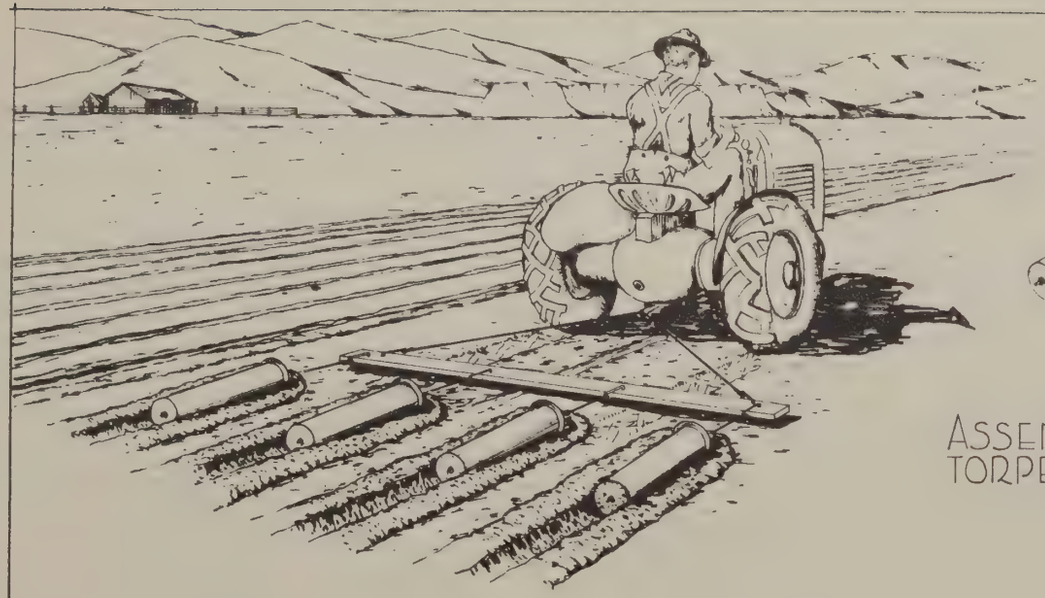


IRRIGATION LEVELER FLOAT

NOTE:- ROLLER CAN BE BUILT AS SHOWN OR CAN BE BUILT OF LOG WITH AUTO AXLES DRIVEN IN ENDS, OR TWO RANGE BOILERS END TO END FOR EACH ROLLER.

USDA	FARM SECURITY ADMINISTRATION	USDA
DENVER COLORADO	IRRIGATION STRUCTURES	F. 513-6 D. 9/23/42
Des. WOOD	Dr. MOORE	Tr. REVISED 8-11-43	Ck.

FIG. 27

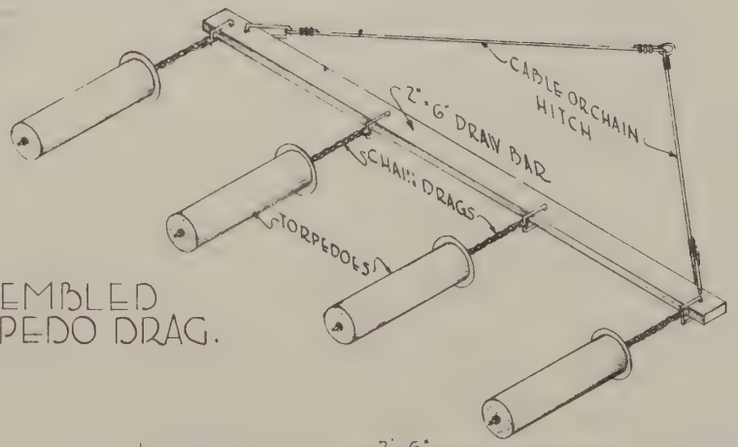


THE TORPEDO TYPE FURROW OPENER IS USED ON FLAT LANDS AND POROUS SOILS. A FURROW IS OPENED BY THE DISC AND COMPACTED BY THE WEIGHT OF THE CONCRETE BARREL. BY DRIVING AT ORDINARY SPEEDS, GOOD ALIGNMENT CAN BE ACCOMPLISHED.

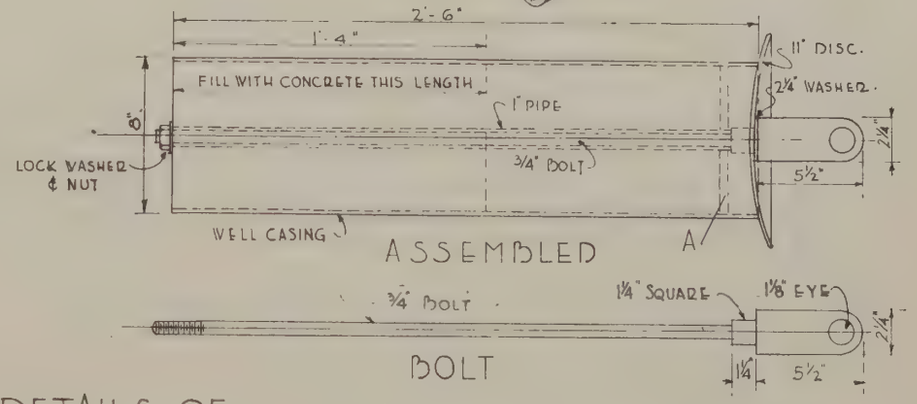
THE SMOOTH PACKED FURROW ALLOWS IRRIGATION WATER TO PROGRESS AT A UNIFORM RATE TO THE LOWER END OF A FIELD WITH A MINIMUM OF DEEP PERCOLATION LOSSES.

TORPEDO TYPE FURROW OPENER

FURROW OPENER AND PACKER FOR USE ON FLAT SANDY GROUND.



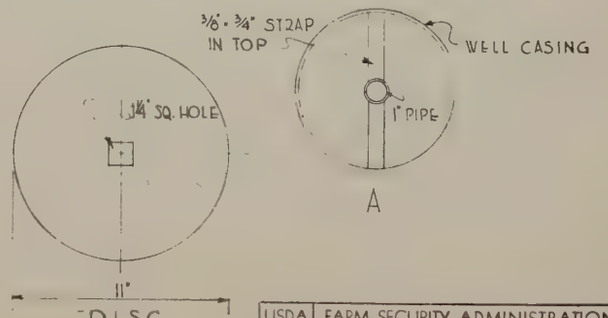
ASSEMBLED TORPEDO DRAG.



ASSEMBLED

BOLT

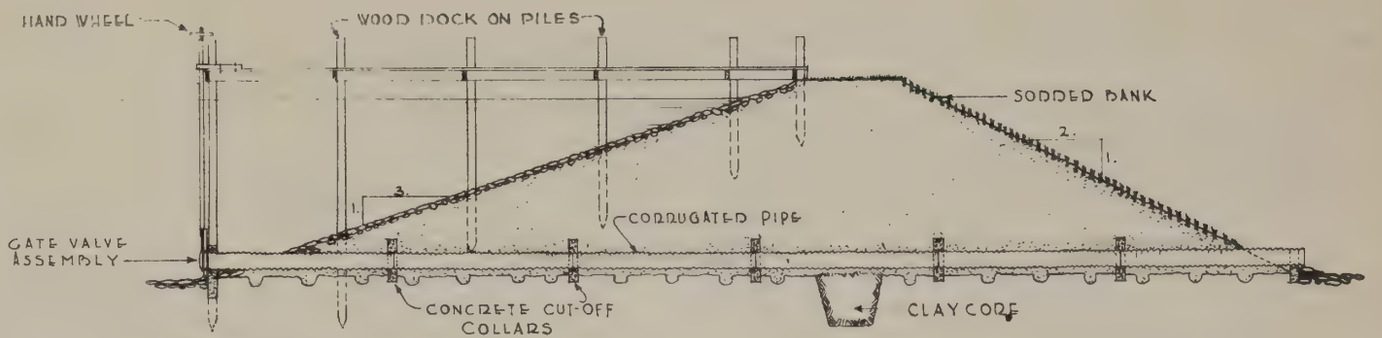
DETAILS OF TORPEDO



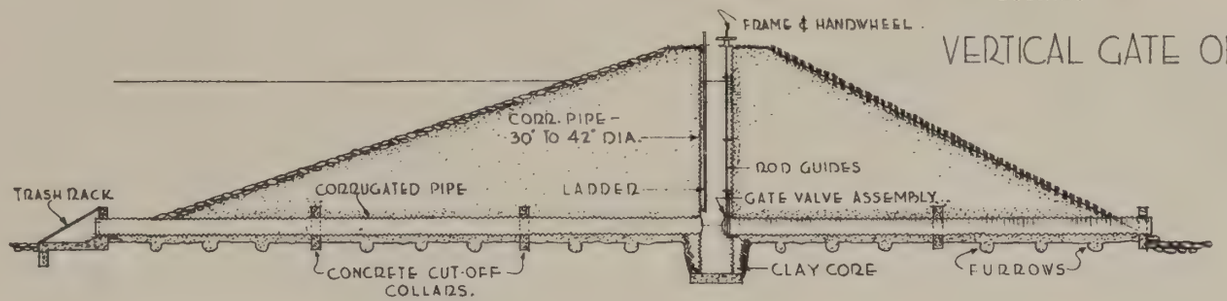
DISC.

USDA	FARM SECURITY ADMINISTRATION	USDA
DENVER	IRRIGATION	F.313:34
COLORADO	STRUCTURES	D.4-8-43
Des. PIERCE	Dr. MOORE	Tr. MOORE	Ck.

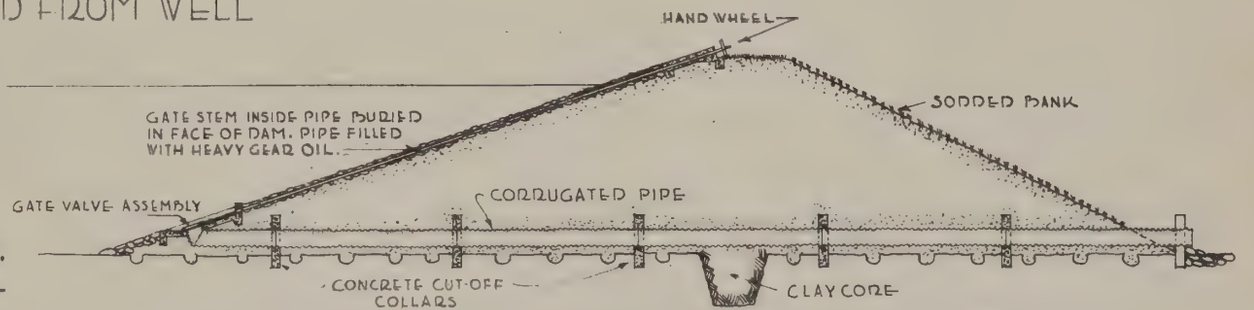
FIG. 28



VERTICAL GATE OPERATED FROM CATWALK



VERTICAL GATE OPERATED FROM WELL



SLOPING TYPE GATE CONTROL PARALLEL TO UPPER FACE OF DAM

OUTLETS THROUGH EARTH-FILL DAMS

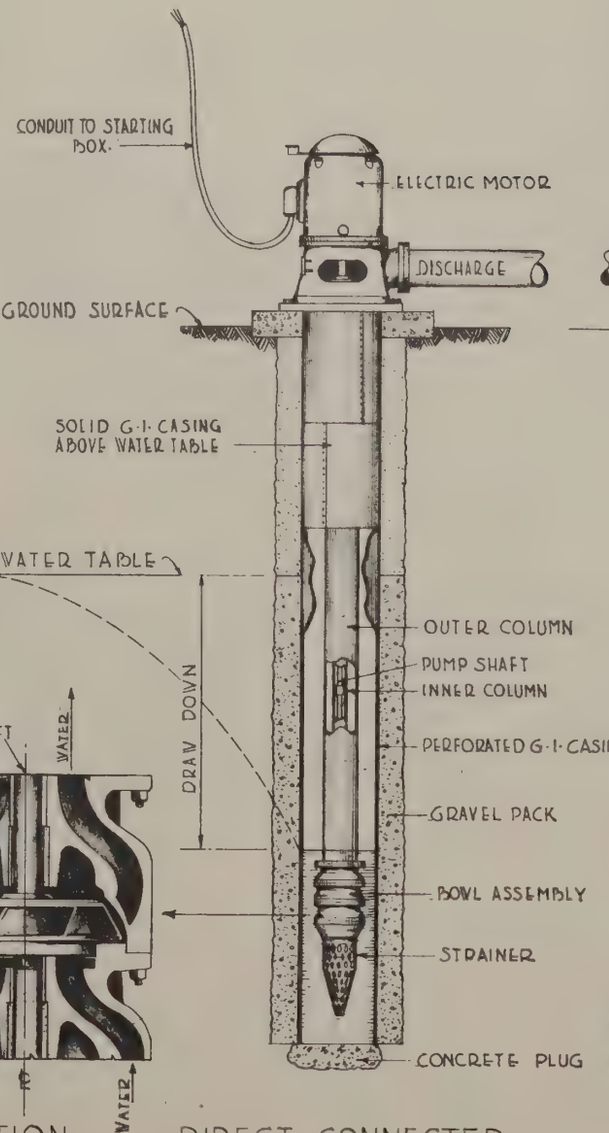
BY PROVIDING AN OUTLET THROUGH THE DAM, WATER IMPOUNDED ABOVE CAN BE USED FOR IRRIGATION PURPOSES IN ADDITION TO STOCK WATER. THREE TYPES OF OUTLETS ARE SHOWN TO MEET LEGAL REQUIREMENTS OF VARIOUS STATES. IN STATES WHERE ICE IS A PROBLEM, THE VERTICAL GATE OPERATED FROM A WELL, OR THE SLOPING TYPE GATE CONTROL HAVE BEEN FOUND TO BE MORE PRACTICAL. HOWEVER, THE TYPE USED MUST CONFORM TO STATE LAWS GOVERNING OUTLET STRUCTURES THROUGH DAMS.

THE SIZE OF THE OUTLET DEPENDS ON THE AMOUNT OF WATER AVAILABLE AND THE SIZE OF THE AREA TO BE IRRIGATED.

THREE TYPES OF OUTLETS THRU EARTH-FILL DAMS

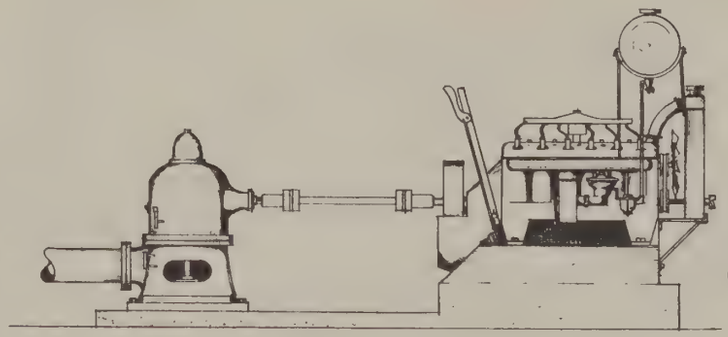
USDA	FARM SECURITY ADMINISTRATION	USDA
DENVER COLORADO	IRRIGATION STRUCTURES	F.313:33 D.4/7/43
Des. STOKER	Dr. MOORE	Tr. MOORE	Ck.

FIG. 29

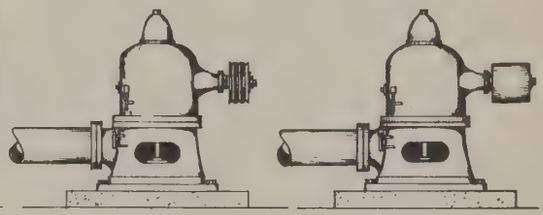


SECTION — TYPICAL BOWL ASSEMBLY

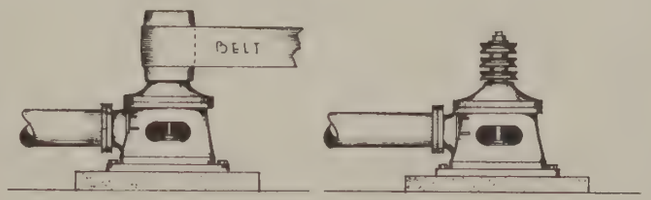
DIRECT CONNECTED MOTOR DRIVEN TURBINE IRRIGATION PUMP



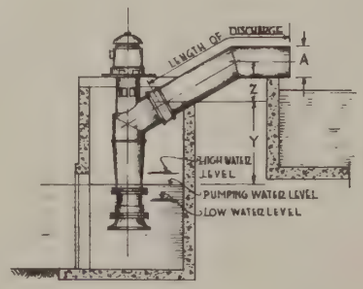
TURBINE TYPE IRRIGATION PUMP WITH GEAR HEAD CONNECTED TO A POWER UNIT WITH A SHAFT AND DOUBLE UNIVERSAL JOINT.



IRRIGATION PUMP GEAR HEAD WITH EITHER V-BELT OR FLAT-BELT DRIVE PULLEY.



TURBINE TYPE IRRIGATION PUMP WITH HEAVY DUTY BELTED HEAD FOR EITHER FLAT OR V-TYPE BELTS.



PROPELLER TYPE IRRIGATION PUMP

TURBINE AND PROPELLER TYPE IRRIGATION PUMPS

THE TURBINE TYPE IRRIGATION PUMP IS ADAPTED TO LIFTING WATER FROM WELLS OF VARIOUS DIAMETERS AND THROUGH VARIOUS HEADS FROM A FEW FEET TO SEVERAL HUNDRED FEET. THE CHARACTERISTICS OF THE PUMP ARE DETERMINED LARGELY BY THE DESIGN OF THE BOWL ASSEMBLY AND THE SPEED OF THE IMPELLER SHAFT.

IN ORDER TO DETERMINE THE TYPE OF PUMP AND DESIGN OF BOWL ASSEMBLY REQUIRED FOR THE BEST EFFICIENCY UNDER GIVEN CONDITIONS THE MANUFACTURER SHOULD HAVE THE FOLLOWING INFORMATION:

1. THE DISCHARGE OF THE WELL AT VARIOUS STAGES OF "DRAW DOWN". THIS IS DETERMINED BY A PUMP TEST OF THE WELL.
2. THE DIAMETER OF THE WELL CASING.
3. THE TYPE OF POWER TO BE USED FOR DRIVING THE PUMP.

WHERE THREE PHASE ELECTRICAL ENERGY IS AVAILABLE, THE DIRECT CONNECTED MOTOR DRIVE MAY BE USED. OTHER TYPES OF DRIVES FOR THE TURBINE PUMP ARE SHOWN.

THE PROPELLER TYPE PUMP IS ADAPTED TO LIFTING LARGE VOLUMES OF WATER THROUGH LOW HEADS. IN IRRIGATION PRACTICE IT IS USED TO DELIVER WATER FROM A STREAM OR LAKE TO A CANAL AT HIGHER LEVEL OR FROM A LOW LEVEL CANAL TO ONE AT A HIGHER LEVEL. THE SAME TYPES OF DRIVES AS SHOWN FOR THE TURBINE ARE ADAPTED TO THE PROPELLER PUMP.

FIG. 30

TURBINE AND PROPELLER TYPE IRRIGATION PUMPS.

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER COLORADO	IRRIGATION STRUCTURES		F. 313: 36 D. 4-15-43
Des. WOOD	Dr. MOORE	Tr. MOORE	Ck.

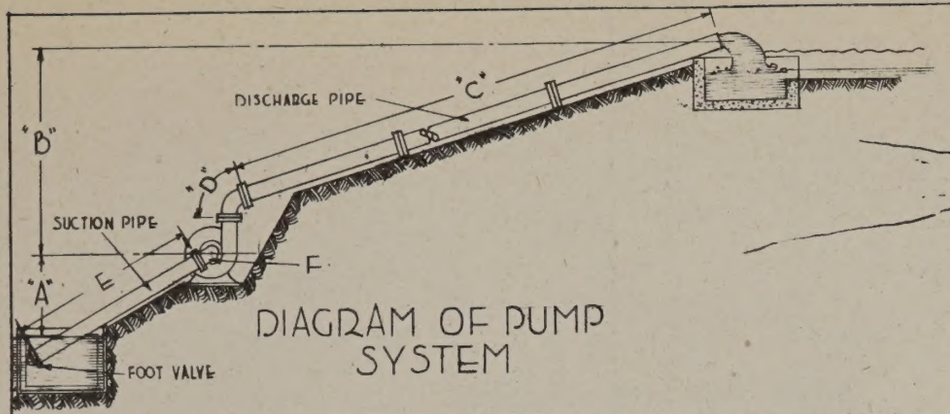
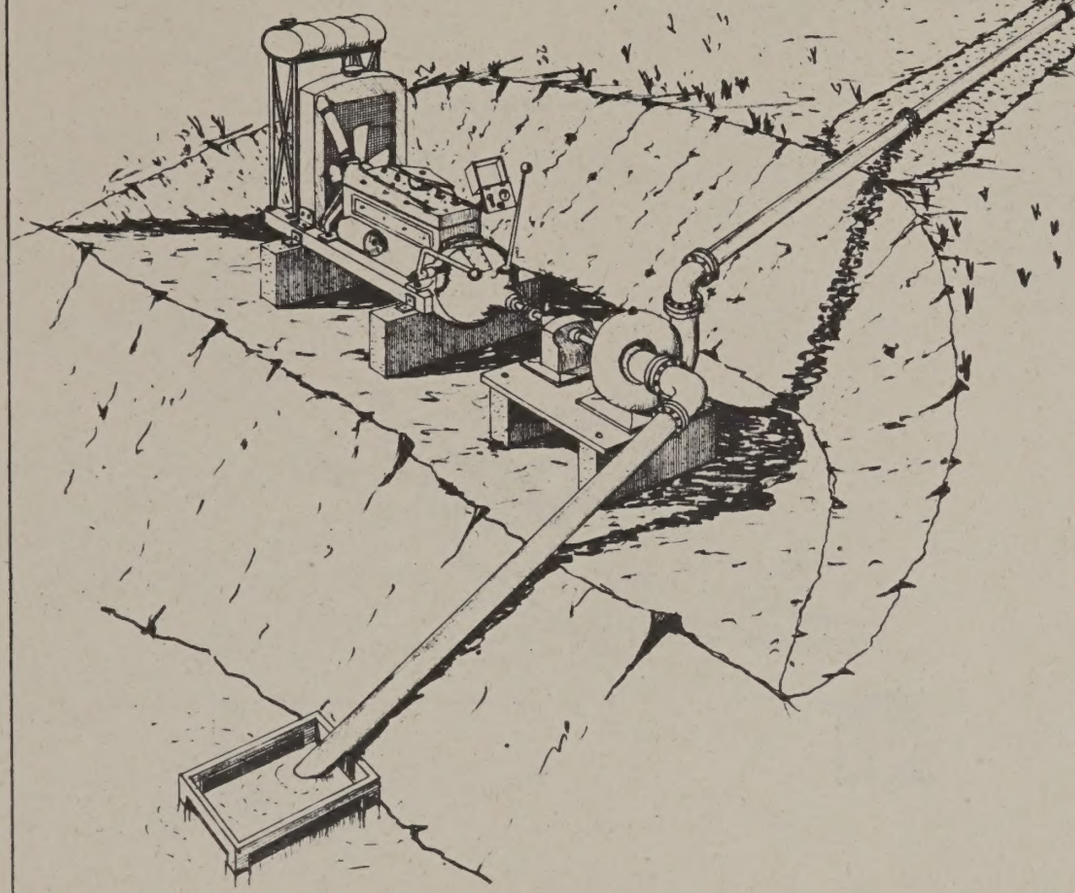


DIAGRAM OF PUMP SYSTEM



INSTALLATION OF A HORIZONTAL CENTRIFUGAL PUMP.

THE HORIZONTAL CENTRIFUGAL PUMP IS WELL ADAPTED TO PUMPING FROM STREAMS, LAKES, OR FROM ONE CANAL TO ANOTHER. THE CHARACTERISTICS OF THIS TYPE OF PUMP ARE DETERMINED LARGELY BY THE DESIGN AND SPEED OF THE IMPELLER. THE MANUFACTURER SHOULD HAVE THE FOLLOWING INFORMATION IN ORDER TO FURNISH A PUMP WHICH WILL GIVE THE BEST EFFICIENCY UNDER GIVEN CONDITIONS:

1. THE QUANTITY OF WATER DESIRED IN GALLONS PER MINUTE OR CUBIC FEET PER SECOND.
2. THE TOTAL "HEAD" OR LIFT IN FEET.
3. THE TYPE OF POWER AVAILABLE AND PROBABLE SPEED AT WHICH THE PUMP WILL OPERATE.

THE TOTAL "LIFT" OR "HEAD" INCLUDES NOT ONLY THE ACTUAL VERTICAL DISTANCE IN FEET TO WHICH WATER MUST BE LIFTED AS A+B IN THE SKETCH BUT ALSO THE FRICTION HEAD IN THE PIPE AND PIPE FITTINGS.

THE SIZE OF THE SUCTION AND DISCHARGE PIPE MUST BE ADAPTED TO THE QUANTITY OF WATER TO BE PUMPED. THE TABLE BELOW INDICATES THE LOST HEAD DUE TO FRICTION PER 100 FEET OF LENGTH AS WELL AS THE LOSSES THROUGH PIPE FITTINGS IN TERMS OF EQUIVALENT LENGTHS OF PIPE.

FRICTION LOSS PER 100 FEET OF COMMON USED PIPE AND LOSS DUE TO FITTINGS

GALLONS PER MINUTE	DIAMETER OF PIPE				
	4-IN.	5-IN.	6-IN.	8-IN	10-IN.
	FRICTION HEAD IN FEET				
400	15.82	5.33	2.21	0.56	-----
450	19.75	6.65	2.74	0.64	0.21
500	24.08	8.12	3.26	0.81	0.28
750	-----	17.22	7.00	1.74	0.59
1,000	-----	-----	12.04	3.02	1.01
1,250	-----	-----	18.20	4.45	1.51
1,500	-----	-----	-----	6.27	2.09
2,000	-----	-----	-----	10.71	3.50
FRICTION LOSSES THRU PIPE FITTINGS IN TERMS OF EQUIVALENT LENGTHS OF PIPE					
GATE VALVE	3.44	4.57	5.72	8.10	10.70
MEDIUM SWEEP ELBOW	5.77	7.68	9.61	13.60	17.97
STND ELBOW	9.22	12.20	15.30	21.71	28.70

AN EXAMPLE: (SEE SKETCH)

LET A+B = 20 FEET ACTUAL HEAD.
LET C+E = 200 FEET ACTUAL LENGTH OF 8-INCH DISCHARGE AND SUCTION PIPE.
D = MEDIUM SWEEP ELBOW EQUIVALENT TO 13.6 FEET OF 8-INCH PIPE.
F = STANDARD ELBOW EQUIVALENT TO 21.7 FEET OF 8-INCH PIPE.

COMPUTE TOTAL HEAD WHEN PUMP IS DELIVERING 1000 GALLONS PER MINUTE.

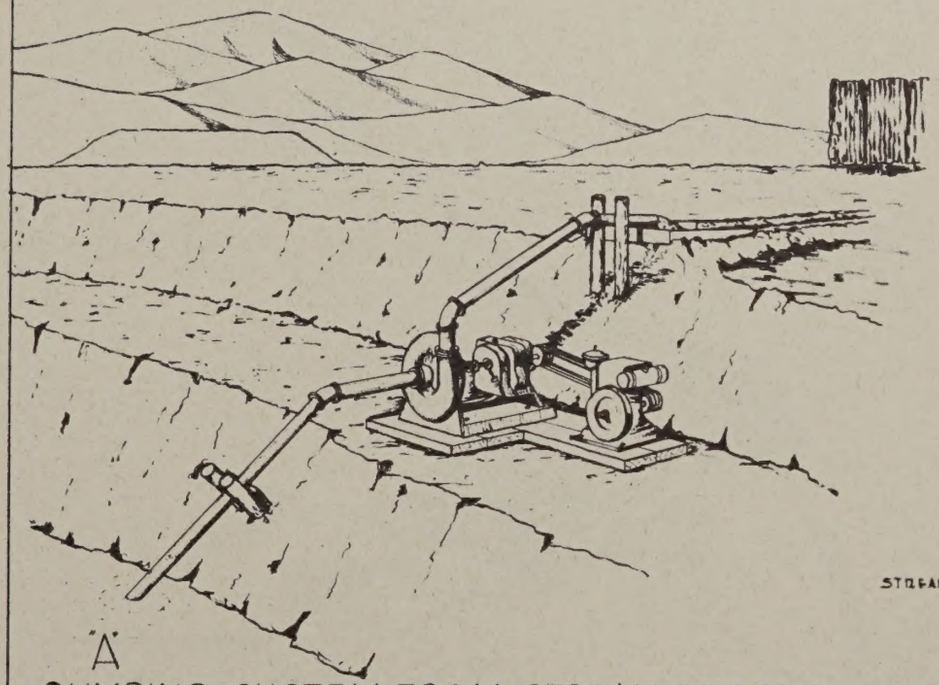
AN 8-INCH PIPE HAS 3.02 FEET OF FRICTION HEAD FOR 100 FEET OF LENGTH WHEN CARRYING 1000 GAL. PER MINUTE. TOTAL FRICTION HEAD IN PIPE AND ELBOWS IS (200 + 13.6 + 21.7) x .030 OR 7.05 FT. TOTAL HEAD IS 7.05 FEET FRICTION HEAD + 20 FT. ACTUAL HEAD = 27.05 FEET.

THERE IS A SLIGHT ADDITIONAL LOSS DUE TO THE FOOT VALVE AND OTHER FACTORS

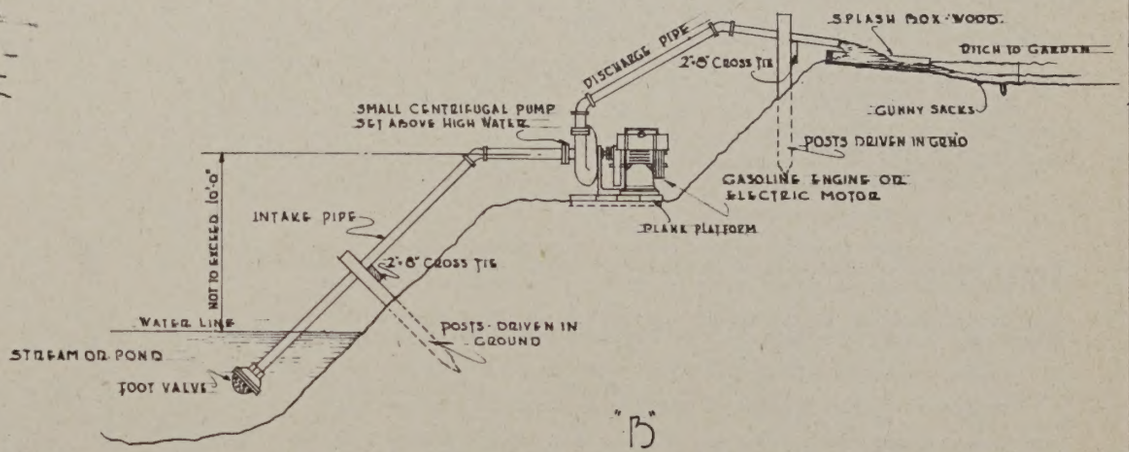
FRICTION LOSS TABLE BASED ON COMMON USED PIPE.

USDA	FARM SECURITY ADMINISTRATION		USDA
DENVER COLORADO	IRRIGATION STRUCTURES		F. 313:38 D. 4-17-43
Des. PIERCE	Dr. MOORE	Tr. MOORE	Ck.

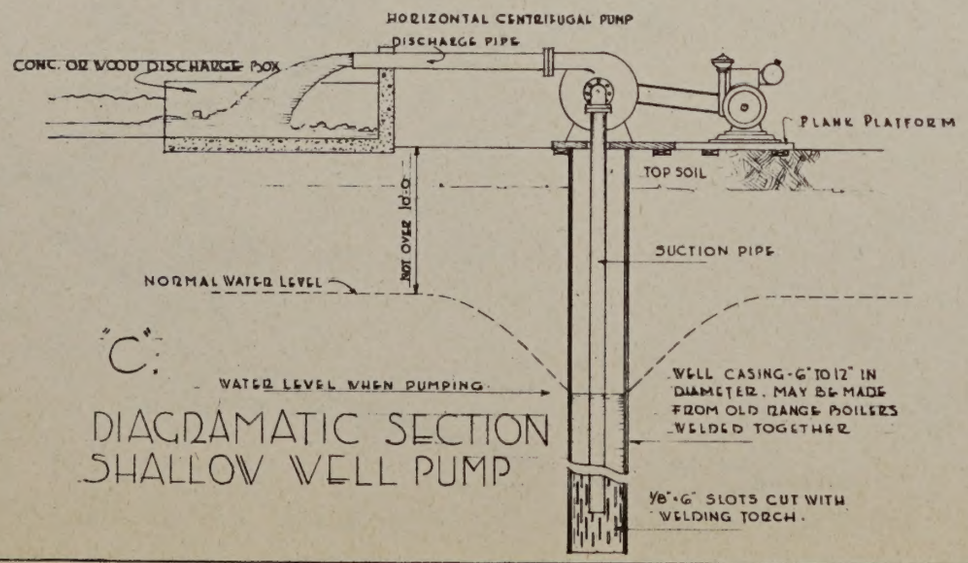
FIG. 31



"A"
PUMPING SYSTEM FROM STREAM OR POND



"B"
DIAGRAMATIC SECTION OF PUMP SYSTEM FROM STREAM OR POND



"C"
DIAGRAMATIC SECTION SHALLOW WELL PUMP

PUMPING FROM A STREAM OR POND

GARDEN IRRIGATION CAN BE ACCOMPLISHED BY PUMPING FROM PONDS AND STREAMS IF THE LIFT IS NOT TOO GREAT. A SMALL HORIZONTAL CENTRIFUGAL PUMP SET NOT HIGHER THAN 10 FEET ABOVE THE WATER AND POWERED BY A GASOLINE ENGINE IS THE EQUIPMENT ORDINARILY USED. PUMPS OF THIS TYPE MAY BE HAD IN SIZES WHICH WILL DELIVER FROM 30 TO 1000 GALLONS OR MORE PER MINUTE.

PUMPING FROM SHALLOW IRRIGATION WELLS

ALONG RIVER BOTTOMS WHERE THE GROUND WATER LEVEL IS PERMANENTLY WITHIN 10 FEET OR LESS FROM THE SURFACE, SMALL IRRIGATION WELLS MAY BE SUCCESSFULLY USED FOR THE IRRIGATION OF FARM GARDENS. CASINGS FOR SUCH WELLS ARE ORDINARILY MADE FROM SHEET METAL SLOTTED TO PERMIT WATER TO ENTER. IN SOME INSTANCES OLD RANGE BOILERS WITH THE ENDS CUT OUT ARE WELDED TOGETHER AND SLOTTED WITH A WELDING TORCH. SMALL CENTRIFUGAL PUMPS SET AT THE GROUND SURFACE ARE QUITE SATISFACTORY.

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DENVER	IRRIGATION STRUCTURES		F.313:10
COLORADO			D.12/16/42
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FIG. 32

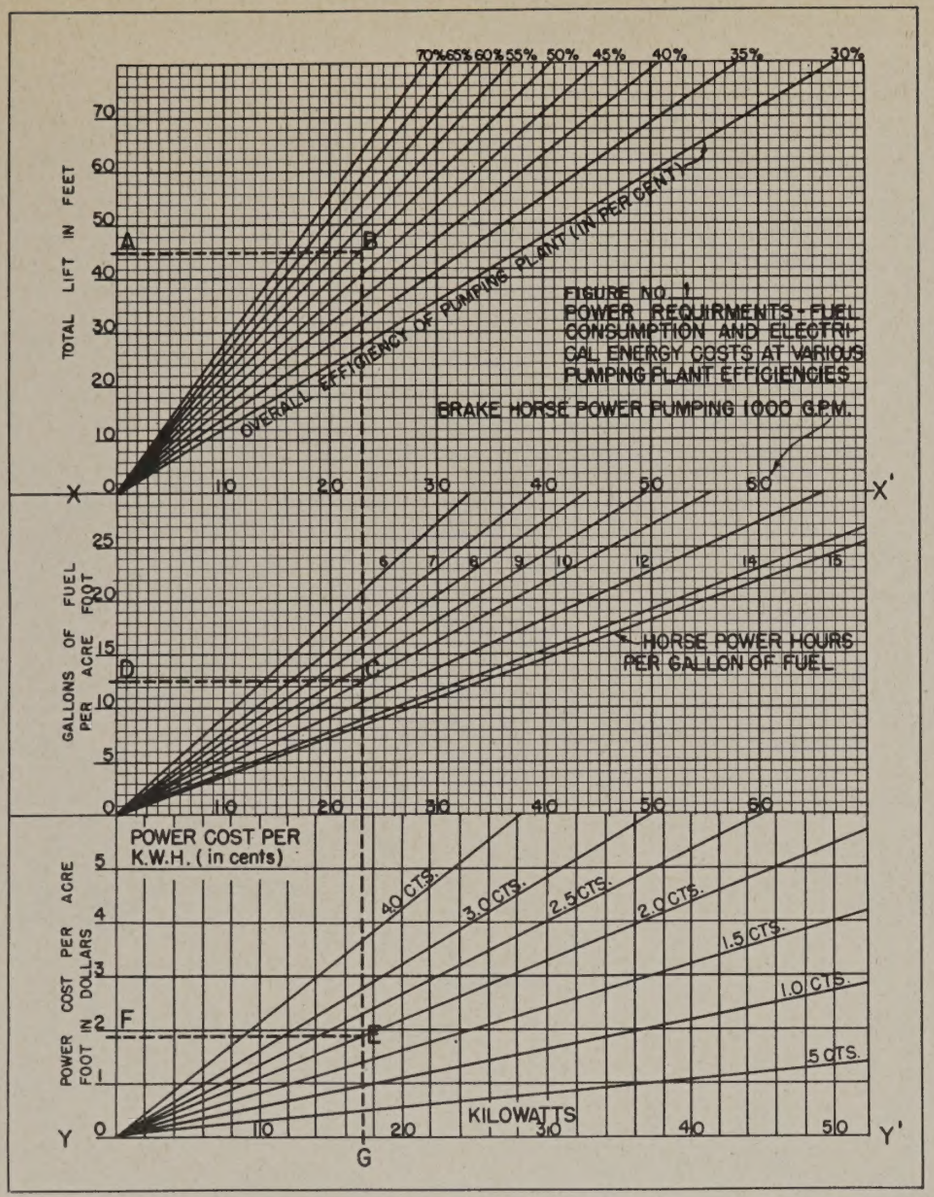

FIGURE NO. 1
POWER REQUIRMENTS + FUEL CONSUMPTION AND ELECTRICAL ENERGY COSTS AT VARIOUS PUMPING PLANT EFFICIENCIES

POWER REQUIREMENT CHART

BY MEANS OF THIS CHART IT IS POSSIBLE TO DETERMINE POWER REQUIREMENTS, FUEL CONSUMPTION, AND ELECTRICAL ENERGY COSTS AT VARIOUS PUMPING PLANT EFFICIENCIES AND AT VARIOUS LIFTS.

AT "A" AT THE UPPER LEFT IS THE SCALE OF LIFTS FROM 0 TO 80 FEET. THE LIFT MUST INCLUDE NOT ONLY STATIC HEAD BUT FRICTION AND VELOCITY HEADS AS WELL.

AT "B", UPPER CENTER, OVERALL PLANT EFFICIENCIES ARE REPRESENTED. OVERALL EFFICIENCIES OF SMALL, IRRIGATION PUMPING PLANTS RUN FROM 40% TO 60%.

ON THE LINE X-X' IS SHOWN HORSE POWER VALUES WHEN PUMPING 1000 GALLONS PER MINUTE.

IN THE CENTER OF THE CHART, AT "C", THE FUEL CONSUMPTION OF VARIOUS TYPES OF ENGINES IS REPRESENTED.

THE APPROXIMATE NUMBER OF HORSE POWER HOURS DEVELOPED PER GALLON OF FUEL FOR VARIOUS TYPES OF ENGINES IS GIVEN BELOW:

TYPE OF ENGINE	HORSE POWER HOURS PER GALLON OF FUEL
GASOLINE ENGINES IN POOR REPAIR	6 TO 7
GASOLINE ENGINES IN GOOD REPAIR	8 TO 9-1/2
ENGINES USING FUEL OIL, SEMI-DIESEL, ETC.	9 TO 11
HIGH SPEED DIESEL	11 TO 14.5

AT THE LOWER PART OF THE CHART "E" IS GIVEN THE POWER COST IN DOLLARS PER ACRE FOOT OF WATER PUMPED AT VARIOUS RATES IN CENTS PER KILOWATT HOUR.

THE LINE Y-Y' AT THE BOTTOM OF THE CHART REPRESENTS THE POWER REQUIRED IN KILOWATTS, WHEN PUMPING 1000 GALLONS PER MINUTE.

USE OF THE CHART

THE USE OF THE CHART IS SHOWN BY THE FOLLOWING EXAMPLE:

THE LIFT OF A GIVEN IRRIGATION PUMP IS 45 FEET; THE OVERALL EFFICIENCY OF THE PLANT IS ESTIMATED AT 50%. WHAT WILL BE THE HORSE POWER REQUIRED TO PUMP 1000 GALLONS PER MINUTE? HOW MANY GALLONS OF FUEL WILL BE REQUIRED TO PUMP AN ACRE FOOT OF WATER, USING FUEL OIL IN AN ENGINE OTHER THAN DIESEL? WHAT WOULD BE THE COST IN DOLLARS PER ACRE FOOT, USING ELECTRICITY AT 2¢ PER KILOWATT?

STARTING AT THE UPPER LEFT HAND MARGIN LOCATE THE LIFT, 45 FEET AT POINT "A". FOLLOW TO THE RIGHT UNTIL THE 50% EFFICIENCY LINE IS INTERSECTED AT POINT "B".

FROM THE POINT "B" FOLLOW DOWNWARD UNTIL THE LINE X-X' IS INTERSECTED. IT WILL BE NOTED THAT 23 HORSE POWER IS REQUIRED TO PUMP 1000 GALLONS PER MINUTE. CONTINUE DOWNWARD UNTIL THE LINE REPRESENTING 10 HORSE POWER HOURS PER GALLON IS INTERSECTED AT "C". FROM THE POINT "C" FOLLOW TO THE LEFT TO THE POINT "D" WHICH SHOWS THAT 12.5 GALLONS OF FUEL WILL BE REQUIRED TO PUMP AN ACRE FOOT OF WATER.

IF THE COST IN DOLLARS PER ACRE FOOT IS REQUIRED, WITH ELECTRICAL ENERGY COSTING 2¢ PER KILOWATT HOUR, FOLLOW DOWNWARD FROM POINT "C" TO POINT "E" ON THE DIAGONAL LINE SHOWING 2¢ COST. FROM POINT "E" FOLLOW TO THE LEFT TO POINT "F" WHICH SHOWS THE COST OF PUMPING ONE ACRE FOOT WATER UNDER THE GIVEN CONDITIONS TO BE $1.90.

IF THE ELECTRICAL LOAD IS REQUIRED, FOLLOW DOWNWARD FROM "E" TO POINT "G" WHICH SHOWS A VALUE OF 17¢.

IF LIFTS OTHER THAN THOSE SHOWN ARE TO BE USED, CERTAIN ALLOWANCES MUST BE MADE. IF VALUES FOR A 100 FOOT LIFT ARE DESIRED, THOSE GIVEN FOR A 50 FOOT LIFT MAY BE DOUBLED, ETC.

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DENVER COLORADO	IRRIGATION STRUCTURES	F. 313:9 D.9/30/42
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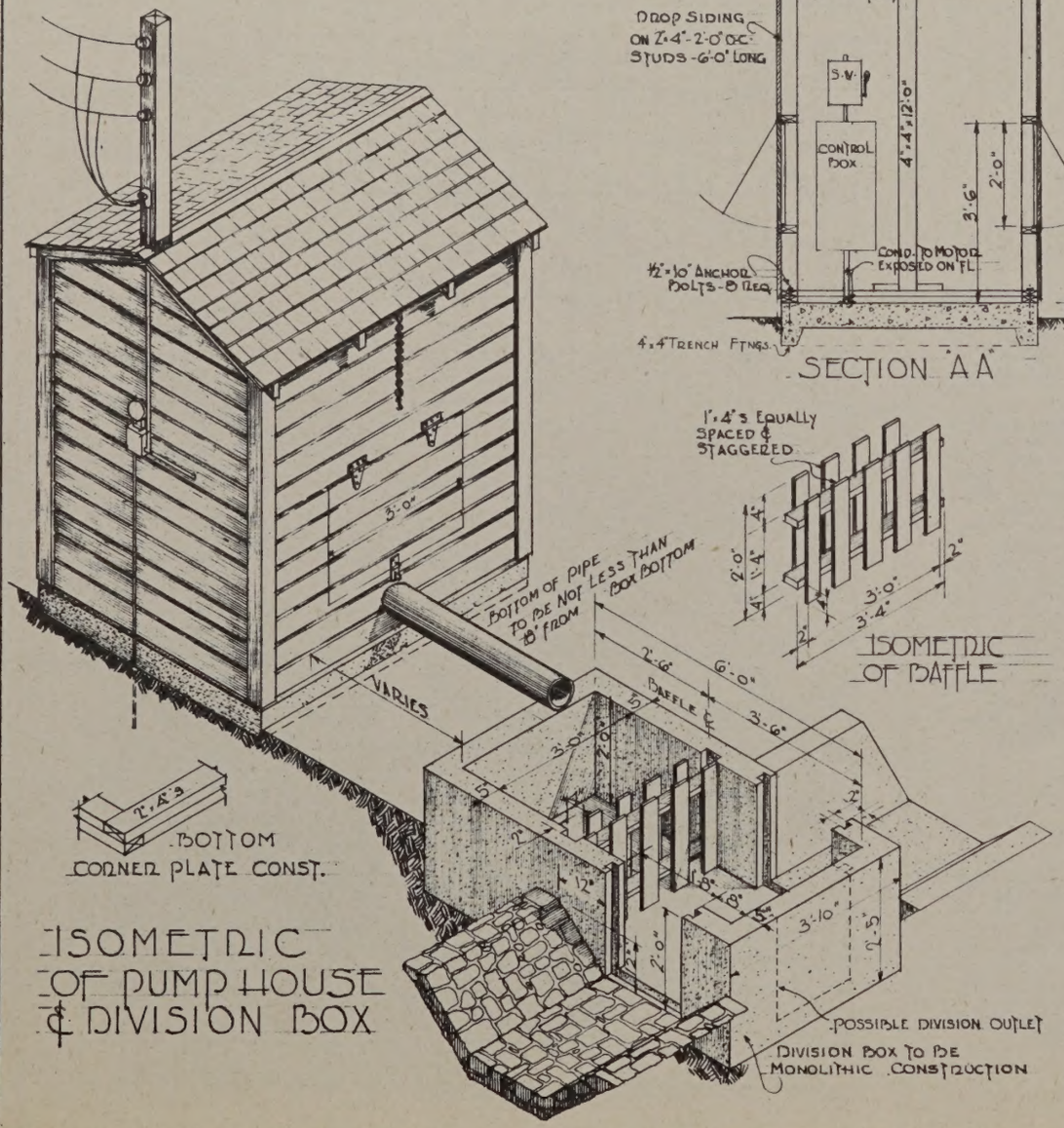
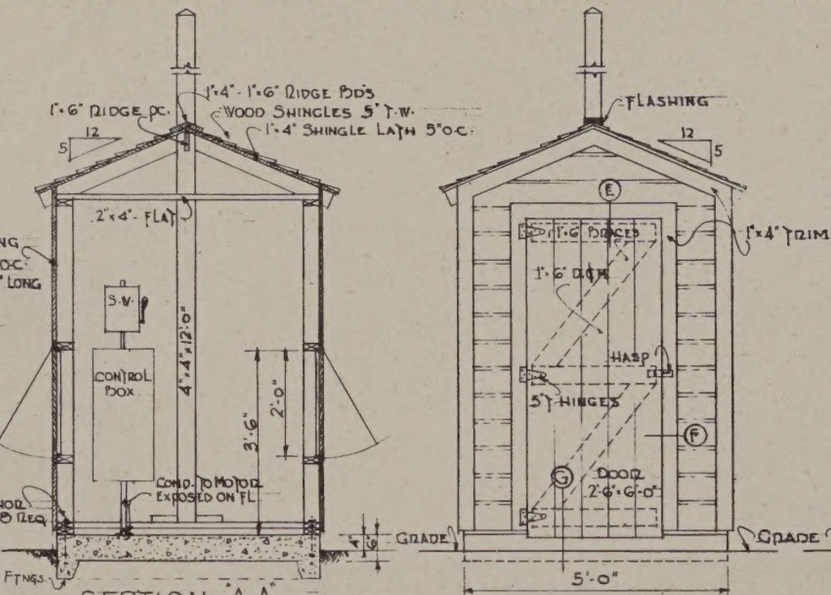
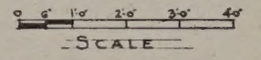
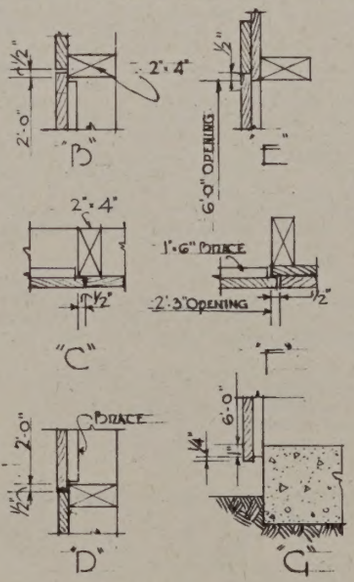
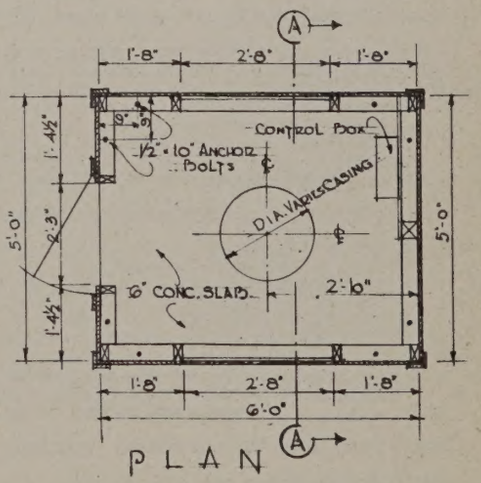


ISOMETRIC OF PUMP HOUSE & DIVISION BOX









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DENVER COLORADO	IRRIGATION STRUCTURES	F. 313:7 D. 3/20/42
Des. PIERCE	Dr. MOORE	Tr.

FIG. 34